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# An econometric study of Argentina

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AN ECONOMETRIC STUDY OF ARGENTINA

by

Efstathios Papageorgiou

A Thesis Submitted to the  
Graduate Faculty in Partial Fulfillment of  
The Requirements for the Degree of  
MASTER OF SCIENCE

Major Subject: Economic Theory

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Signatures have been redacted for privacy

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## INTRODUCTION

The interest, that most of the governments have shown in recent years, either for economic growth or economic stability led to the creation of a new area in the field of economics, that of the theory of economic policy.

J. Tinbergen gives the following description of economic policy in his book "On the Theory of Economic Policy" [22, p. 3].

"As the broadest object of the theory of economic policy we consider the determination of optimum policy, given the individual preference indicators of the citizens of a community. The object is very broad indeed and implies among other things:

- i) The fixation of a collective preference indicator;
- ii) The deduction, from this indicator, of the targets of economic policy generally;
- iii) The choice of "adequate" instruments, qualitative and quantitative;
- iv) The determination of the quantitative values of the instrument variables as far as such instruments are chosen and
- v) The formulation of the connections between (a) the relation between targets and quantitative values of instrument variables on the one hand and (b) the structure of the economy studied on the other hand".

In the present study an attempt is made to present the essential elements of economic policy, both in a theoretical and empirical



framework. The study consists of two parts.

Part I presents the basic theory of economic policy. The emphasis is placed on quantitative economic policy which deals only with changes in the values of certain parameters within a system. For this reason it has more relevance to stability than to development problems. Nevertheless, the appropriate use of quantitative economic policy will help to understand and solve problems of economic development.

Part II supplies the empirical material for the theory presented in Part I. It consists of two sections. Section I reviews a number of policy models while Section II is the essential part of the present study. It is a modest attempt by the author in utilizing the theory of quantitative economic policy to develop a policy model for Argentina. The main purpose of this last section is to go through the process of developing a model rather than in applying it to policy uses.

## CHAPTER I

Introduction

By economic policy is meant the deliberate manipulation of a number of means to attain certain aims.

The ends of economic policy can be attained with the help of three different kind of means: a) quantitative policy, b) qualitative policy and c) reforms.

Quantitative economic policy consists, in the Tinbergen [22] and [23] framework of changes in the values of certain means (instruments), within a fixed structure, to attain certain targets.

In qualitative policy structural changes themselves are used as policy means. Reforms go further, since changes are introduced to the overall institutional systems (i.e., including the social and the political structure).

At times it is hard to distinguish if a certain policy is of a quantitative or of qualitative nature. As an example, take the introduction of personal income tax. This could be interpreted as quantitative policy if it is looked upon simply as a quantitative change in a tax parameter from a zero to a positive rate. Alternatively it could be interpreted as being of a qualitative nature since a new mean was introduced into the system. The important thing in distinguishing quantitative from qualitative policy is to see if the economic policy act introduces structural changes. For this reason a broad definition of "structural changes" is needed.

Chakravarty [4, p. 28] has described structural changes in the

following way.

"If we divide the economy into a number of sectors consistent with the given classification of commodities the number of these producing sectors could be regarded as an invariant of a given structural situation. If this number is changed as a consequence of any programme of industrialization we say that a structural break has taken place ..."

Most of the quantitative policy models assume a given economic structure (as is defined in the first part above). This is true even if the models are dynamic (either of a continuous or discrete nature).

Dynamic models can only show the behavior of an economic system in response to certain initial conditions and to certain external influences (policy changes which leave the structure of the system unchanged). What is implied by the above is that quantitative policy models show only the time-path of the endogenous variables on the basis of certain initial conditions and an unchanged structural framework. This eliminates discontinuities from the system, and for that reason this type of model can be used for stabilization policies.

On the other hand economic development implies a deliberate decision to change the existing economic structure. It introduces discontinuities which can not be handled by the typical quantitative policy model. These discontinuities take the form of structural changes (as defined in the second part of Chakravarty's quotation).

Will it then be contradictory to use quantitative economic policy to formulate a model for a developing economy?

Not exactly, since quantitative policy could be used to derive a

short term policy model. Structural changes as defined here do not take place continuously over time, but in a discrete fashion. This implies that the planning horizon can be divided into three time segments.

- a) From  $t=0$  up to the moment that the structural change is initiated ( $t=1$ )
- b) From  $t=1$  up to the moment that the structural change is completed and
- c) From the time the structural change is completed until a new structural change is to be introduced.

In this respect a short term model for period (a) could be developed which among other things could indicate the time and in what sector the structural change should occur. But after the structural change has been completed, it becomes necessary to formulate a new model.

The preceding discussion implies that quantitative economic policy could be indirectly used for development models. This chapter will present the essential elements of quantitative policy, in such a way as to show their relevance to economic development. At the end of the chapter an application of quantitative policy to a stabilization problem will also be presented.

#### Quantitative economic policy<sup>1</sup>

The basic elements of quantitative economic policy are:

- a) Economic variables
- b) The social welfare function (to be called  $W$ ) and
- c) The empirical model which contains equalities and inequalities.

Economic variables are divided into targets, instruments, data and



irrelevant variables.

Targets are a specified set of objectives (such as maximum income) which define the objectives of the policy maker.

Instruments are the means with which targets are attained.

Data are variables that are determined outside the system (and which cannot be influenced by the policy maker).

Irrelevant variables can be influenced by, but are of no interest to, the policy maker.

It is interesting to point out that in economic policy the instruments are exogenous variables and targets endogenous variables while in economic theory the reverse is true.

In economic theory it is assumed that the system will reach the optimum stage by the operation of market forces. In economic policy first the optimum stage is postulated by the policy maker (through targets appearing in the welfare function) and is reached by manipulating the instruments to supplement and correct the operation of the price system.

#### The social welfare function (W)

The social welfare function includes the targets. It may include only targets (fixed or flexible) or targets and instruments. It may be linear or non-linear.

If it includes only fixed targets (instruments) the (W) is of implicit form. The policy maker establishes, for example, a given desired level of the annual rate of growth of Gross National Product (G.N.P.) and through the model will find the instruments values that

are consistent with the targets.

In all the other cases (W) becomes explicit and if linear will take the form

$$(1) \quad W = a_1 P_1 + a_2 P_2 \dots + a_n P_n$$

$P_i$ 's ( $i = 1 \dots n$ ) are the instruments or targets and W is maximized (or minimized) subject to constraints which are given by the model.

The  $a_i$  are weights. The ratios of any two  $a_i$ 's specify the rate of substitution between the  $P_i$ 's consistent with the preference of the policy maker.

The implication of including instruments in (W) is that value connotations are also attached to instruments.

The non-linear (W) is usually quadratic, where (W) usually takes the form of minimizing the sum of the squared differences between the resulting values of the variables (P) and the desired ones ( $P^*$ ).

#### Model

The model specifies the set of quantitative relations (equalities and inequalities) between the variables.

The relations of a model can be divided into the following groups.

(a) Behavioral. Describing the behavior of one economic variable as a function of others.

(b) Technical relations

(c) Identities derived from the system of national income accounts and definitional equations.

Inequalities are included at times to indicate the upper or lower bounds that a variable (both targets and instruments) can take (for example,

per capita consumption should not be below a certain minimum or the increase of money supply above a certain rate).

The solution of the model will give a set of values for the instruments that satisfies the set of fixed goals or alternatively which maximizes the welfare function. Where inequalities are imposed the final values should fall within the prescribed limits.

#### Consistency in the model

Assume that there are  $N$  structural relations,  $(n)$  instruments  $(x)$ ,  $(m)$  targets  $(y)$ ,  $(k)$  data  $(z)$  and  $(l)$  irrelevant variables.

If it is also assumed that each relation is linear or has been linearized then the system is a well determined one if

$$(2) \quad N = m+1,$$

i.e., in an equational sense there is a consistency if the number of endogenous variables is equal to the numbers of equations.<sup>2</sup>

If in addition

$$(3) \quad n = m \text{ (targets = instruments)}$$

then

$$(4) \quad N = n + 1$$

which is the condition that should hold to be able to solve for all unknowns in the economic policy problem (instruments).

If 3 does not hold, then  $n > m$  or  $n < m$ . In the case  $n > m$  then there exist  $(n - m)$  policy degrees of freedom.<sup>3</sup> This implies that  $(n - m)$  instruments can be set arbitrarily by the policy maker and then solve for the rest of the instruments. This way a set of alternative solutions can be found, whether by varying different  $(n - m)$  instruments each time or

by varying a given set of  $(n - m)$  instruments within a certain interval.

In the case that  $n < m$  then from 3 and 4

$N > n + 1$  and the system is overdetermined.

### Reduced form

The reduced form of a system can be found by solving for the set of endogenous variables as functions of the exogenous variables (in economic theory terminology) and eliminating the vector of the irrelevant variables. The reduced form is of importance not only for the actual economic policy but for the parameters estimation problem.

The reduced form of a system is:

$Ay = Bx + Cz$  where  $A$ ,  $B$  and  $C$  are matrices of appropriate dimensions and  $y$ ,  $x$  and  $z$  are the target, instrument and data vectors, respectively.

A solution for the vector  $x$  will exist if  $B$  is a nonsingular square matrix.<sup>4</sup> If  $B$  inverse exists then

$$x = B^{-1}Ay - B^{-1}Cz \quad \text{or}$$

$$x = Gy + Fz$$

If  $x$  is unique then it can be observed that

a) The values of instruments are dependent, in general, on all targets. This implies that the classical assumption of a one-to-one correspondence between a target and an instrument is not valid.

b) That the vector  $x$  varies with vector  $z$  which includes data variables that are sometimes forecasted. This implies that forecasting methods must be highly accurate if the results are to assume any significance [20].



c)  $x$  is directly related to matrices  $G$  and  $F$  which include the statistically estimated parameters of the system. It is very important to test the sensitivity of the vector  $x$  to variations in the  $G$  and  $F$  matrices. The implication being that if  $x$  is quite sensitive to changes in  $G$  or  $F$  then the solution should be taken with caution. Subsequently the concept of optimal reaction function will be employed to describe the essence of this problem.

#### Nature of solution

The nature of the solution of  $x$  depends on the nature of matrices  $G$  and  $F$ .

i) It has already been said that every instrument is, in general, a function of all targets as long as there are no zero elements in the  $G$  matrix. The only case in which a one-to-one correspondence exists between a target and an instrument is when  $G$  is a strictly diagonal matrix.<sup>5</sup> In this case the policy maker can attain a target by using one and the same instrument. This is a rather unrealistic situation.

ii) If  $G$  is strictly triangular then the solution is of a recursive nature.

A recursive model takes the form:

$$\begin{vmatrix} a_{11} & & & & \\ a_{21} & a_{22} & & & \\ \cdot & \cdot & \cdot & & \\ \cdot & \cdot & \cdot & \cdot & \\ \cdot & \cdot & \cdot & \cdot & \cdot \\ a_{n1} & a_{n2} & \cdot & \cdot & a_{nn} \end{vmatrix} \begin{vmatrix} x_1 \\ x_2 \\ \cdot \\ \cdot \\ \cdot \\ x_m \end{vmatrix} = \begin{vmatrix} a_{01} \\ a_{02} \\ \cdot \\ \cdot \\ \cdot \\ a_{0m} \end{vmatrix}$$

and in a diagrammatic form this implies

$$x_1 + x_2 + x_3 + \dots + x_m$$

$x_1$  is determined exogenously (since  $a_{01}$  is a parameter). Given  $x_1$ ,  $x_2$  can be determined from the equation  $a_{21} x_1 + a_{22} x_2 = a_{02}$  (subset of order one) and so on [19].

This allows the policy maker to proceed in stages since policy  $x_1$  can be implemented without consideration for  $x_2 \dots x_m$ . But in solving for  $x_m$  all previous policies are taken into consideration.

iii) If A and B can take the form of a block diagonal matrix<sup>6</sup> then the over-all model could be decomposed into as many independent parts as the number of the blocks. So the instruments contained in each block could be solved without knowledge of values of instruments contained in other blocks.

The above discussion was based upon the assumption that matrix B is nonsingular. If this assumption is removed then equational degrees of freedom are introduced.

If one of the minors of B is nonsingular then one of the instruments is arbitrarily fixed and the system is solved for the remaining  $(n - 1)$  instruments. In this case the system has  $(m + 1)$  degrees of freedom, i.e., all the targets plus the one instrument. This case is similar to one where  $n > m$ .

#### Efficiency of instruments

An important concept of quantitative policy is the efficiency of instruments.

The above concept expresses the effectiveness of an instrument,  $x$ , in inducing a change in target  $y_i$  when all other instruments are held

constant.

This definition of efficiency is applicable whenever  $W$  is an implicit one.

In case that the Social Welfare Function takes the explicit form of  $W = F(x_1 x_2 \dots x_n, y_1 \dots y_m)$  and if it is assumed that  $W$  is differentiable then after some appropriate substitutions the instrument values which maximize  $W$  are given by:

$$(5) \quad \frac{\partial W}{\partial x_1} = \sum_j \left[ \frac{\partial W}{\partial y_j} \cdot \frac{\partial y_j}{\partial x_1} + \frac{\partial W}{\partial x_1} \right]$$

The efficiency here is given by:

$$\frac{\partial W}{\partial x_1}$$

while  $\frac{\partial y_j}{\partial x_1}$  gives the effectiveness of instrument  $x_j$  on target  $y_j$ ; so the

$\sum \frac{\partial y_j}{\partial x_1}$  expresses the sum of effectiveness of instrument  $x_1$  on all targets

$y_1$ .

#### A mathematical solution to a policy problem

In this section the solution of a maximization problem will be given.  $W$  is of quadratic form and includes both instruments and targets and the model is linear. It was already mentioned that vector  $x$  is sensitive to variation in the  $G$  matrix (i.e., the estimated parameters). To see to what extent this is true the concept of optimal reaction function is used. First the solution of the problem will be given.

The quadratic ( $W$ ) in matrix form<sup>7</sup>

$$(6) \quad W = a'x + b'y + \frac{1}{2}[x'Ax + y'By + x'Cy + y'Cx].$$

is maximized subject to

$$(7) \quad x = Gy + S,$$

where  $x$  and  $y$  are respectively the instruments and targets vectors.

The Lagrangean equation:

$$\text{Max}(L) = W(x, y) - \lambda[x - Gy - S]$$

is maximized by taking partial derivatives with respect to  $x$ ,  $y$  and  $\lambda$ ,

and equating them to zero:

$$(8) \quad \frac{\partial L}{\partial x} = b + By + \frac{1}{2}C'x + \frac{1}{2}C'x - G'\lambda = 0$$

$$(9) \quad \frac{\partial L}{\partial y} = a + Ax + \frac{1}{2}Cy + \frac{1}{2}Cy - \lambda = 0$$

$$(10) \quad \frac{\partial L}{\partial \lambda} = -x + Gy + S = 0$$

The system to be solved in matrix notation is:

$$(11) \quad \begin{vmatrix} B & C' & -G' \\ C & A & -I \\ G & -I & 0 \end{vmatrix} \begin{vmatrix} y \\ x \\ \lambda \end{vmatrix} = \begin{vmatrix} -b \\ -a \\ -S \end{vmatrix}$$

where  $C$ ,  $B$ ,  $A$  and  $G$  are matrices.

The solution of this system will give the optimum  $x^0$ ,  $y^0$ ,  $\lambda^0$  maximizing the Lagrangean function.

To solve for  $x^0$ ,  $y^0$ ,  $\lambda^0$  the inverse of the  $3 \times 3$  (left hand side) matrix is partitioned in the following way [8, p.2]:

$$(12) \quad \begin{vmatrix} yy & yx & \cdot x \\ yx & xx & \cdot y \\ x \cdot & y \cdot & \cdot \cdot \end{vmatrix}$$

It can be shown that for the problem under discussion

$$yy = [B + G'AG + CG + G'C']^{-1}.$$

Then the solution of the problem is:

$$(13) \quad \begin{bmatrix} y^0 \\ x^0 \\ \lambda^0 \end{bmatrix} = \begin{bmatrix} yy, yyG', yy[C + G'A] \\ G[yy], G[yy]G', G[yy][C + G'A] \\ \end{bmatrix} \begin{bmatrix} -a \\ -b \\ -s \end{bmatrix}$$

$x^0, y^0$  are the optimal reaction functions of the policy maker and can be defined in a general way as

$$x^0 = x(G, S)$$

$$y^0 = y(G, S)$$

where  $G, S$  are the multiplicative and additive structure of the constraints (model).

The above concepts can be used to show the similarities between economic policy and economic theory.

The model has the form,  $x = Gy + S$  which is similar to a consumer budget constraint problem in economic theory.

$G$  is analogous with the price variable (and so the multiplicative structure) while  $S$  is analogous to the consumer's income (and for that reason the additive structure).

Assume that all parameters in the system are changed by  $dG$  and  $dS$  in a matrix form, then  $x^0, y^0$  will be changed by  $dx, dy$  and the new system of equations will be:

$$(14) \quad \begin{bmatrix} B & C' & -(G + dG)' \\ C & A & -I \\ (G + dG) - I & \phi & \end{bmatrix} \begin{bmatrix} y^0 \\ x^0 \\ \lambda^0 \end{bmatrix} = \begin{bmatrix} B & C' & -(G + dG)' \\ C & A & -I \\ (G + dG) - I & \phi & \end{bmatrix} \begin{bmatrix} dx \\ dy \\ d\lambda \end{bmatrix} = \begin{bmatrix} -a \\ -b \\ -S + dS \end{bmatrix}$$



The problem is to estimate  $dx$ ,  $dy$ . From the above system 11 is subtracted:

$$(15) \quad \begin{vmatrix} 0 & 0 & -dR' \\ 0 & 0 & 0 \\ dR & 0 & 0 \end{vmatrix} \begin{vmatrix} y^0 \\ x^0 \\ \lambda^0 \end{vmatrix} + \begin{vmatrix} B & C' & -(G + dG)' \\ C & A & -I \\ (G + dG) - I & \phi & \end{vmatrix} \begin{vmatrix} dy \\ dx \\ d\lambda \end{vmatrix} = \begin{vmatrix} 0 \\ 0 \\ dS \end{vmatrix}$$

Since  $dR$ ,  $y^0$ ,  $x^0$  and  $\lambda^0$  are known quantities they are transferred to the right hand side and by neglecting second order differentials, the left hand side becomes

$$(16) \quad \begin{vmatrix} B & C' & -G \\ C & A & -I \\ G & -I & \phi \end{vmatrix} \begin{vmatrix} dy \\ dx \\ d\lambda \end{vmatrix} = \begin{vmatrix} x^0 dR' \\ 0 \\ dS - y^0 dG \end{vmatrix}$$

The inverse matrix of the left hand side of 16 has already been estimated in 12, so

$$(17) \quad \begin{vmatrix} dy \\ dx \\ d\lambda \end{vmatrix} = \begin{vmatrix} yy, & yyG', & yy[C + G'A] \\ G[yy], & G[yy]G', & G[yy][C + G'A] - I \\ \lambda^0 dR', & 0 & dS - y^0 dG \end{vmatrix}$$

and to estimate changes in targets for changes in parameters:

$$(18) \quad dy = yy\lambda^0 dG' + yy[C + G'A][dS - y^0 dG]$$

or

$$(19) \quad dy = [yy\lambda^0 - yy(C + G'A)y^0]dG + yydS$$

Relation 19 gives the sensitivity of  $y$  to the estimated parameters of the model  $G$  and to the data  $S$ . This relation can be of great value in finding out how reliable the model is.

A change in the  $G$  matrix (multiplicative structure)  $dG$  which is accompanied by a compensated change in  $S$  (additive structure)  $dS$  (in equation 18), i.e.,  $dS = y^0 dG$  will give:

$$dy = yy\lambda^0 dG'$$

which is the substitution effect i.e., the desirability of using some targets, becomes greater than before because  $dG$  has changed.

If only  $dS$  changes,  $dG = 0$ , then from 19

$$dy = yydS$$

This indicates the sensitivity of the target vector to changes in the additive structure. It could be thought of as being equivalent with the income effect from economic theory.

If only  $dG$  changes while  $dS = 0$  then again from 19

$$dy = [yy\lambda^0 - yy(C + G'A y^0)]dG$$

This change in the multiplicative structure will affect the policy in the following way. The  $G$  matrix is composed of the parameters of the instruments and changes in these parameters imply that the relation between instruments (and between instruments and targets) have changed making the use of some instruments more desirable, and also influencing the overall position of the system.

The parallel with consumer's theory is the change in price. Such a change creates not only a substitution effect but also an income effect [9, p.29].

#### Stability and optimality

The problem discussed in the previous section was one of optimization. The case may arise that the expansion path of any one of the variables thus obtained is very unstable and therefore undesirable from a policy standpoint. Thus, in addition to optimization criteria, stability criteria should be introduced in every development model.

There is often a conflicting relationship between optimization and stabilization. To accomplish the one the other must sometimes be sacrificed.

Some economic policy stabilization models have been patterned after engineering feed-back systems [15].

In feed-back systems the desired output, which is used as input signal is compared with the actual, and the difference is used to control the system. In an analogous way instead of comparing the desired output with the actual output, the latter can be compared with another system (which is regulated by the engineer), to derive the optimum value of the regulated system for which the output remains on the desired level. Both systems are described by differential equations and the usual problem is to find for what values of the parameters the system is stable.

A similar approach could be used for problems of economic policy.

The analogies are clear.

Assume that  $y$  stands for the desired level of G.N.P., and  $x$  for the actual level. If  $x$  could be compared with some controllable systems then G.N.P. could be forced to reach the desired output.

But since the system has to be expressed in terms of differential equations there are some important problems involved for the economic application of the feed-back principle. The reason is that differential equations apply only to ideal conditions and do not include the possibility of disturbances which are exogenous to the system (a very common thing in economics).



Another important problem is the difficulty to fit differential equations to discrete data.

Despite these important limitations control theory can give the economist important qualitative guidelines in formulating his policy.

A typical problem in economic policy will be to maximize G.N.P. at time (T) without creating violent fluctuations either in the controlled or in the target variables.

The above problem can be approached through a criterion function which incorporates into the stabilisation problem the maximization of a desired performance. The criterion function is usually an integral over time which includes targets and instruments. The solution vector for the instruments is that which maximizes (or minimizes) the function subject to the model.

It is possible with the use of the calculus of variation to solve this type of problem but the target and instrument space cannot be restricted. This problem can, however, be avoided by using the Pontryagin's principle which is presented and examined in the next section [16].

As was previously stated, a control problem is often described by a system of differential equations. If the system is reduced to a first order one it takes the form:

$$(20) \quad \dot{x}_i = f_i[x(t), u(t), ] \quad i = (1 \dots n)$$

where

$x(t)$  is the target variable vector

$u(t)$  is the instrument variable vector

$t$  is time

The welfare function is expressed by an integral over time. A new function  $x_{n+1}$  is defined in which the right hand side consists of the integral of the welfare function.

The problem consists of finding  $u(t)$  which maximizes<sup>8</sup>  $x_{n+1}$ , i.e.,

$$(21) \quad \text{Max} \sum_{k=1}^{n+1} C_k x_k(T) = 0x_1(T) + 0x_2(T) + \dots + (1)x_{n+1}(T).$$

To solve this problem shadow functions of the form:

$$(22) \quad \dot{p}_i(t) = \sum_{s=1}^{n+1} p_s(t) \frac{\partial \dot{x}_s}{\partial x_i}$$

where  $\dot{x}_s = f_s(x, u, t)$  are defined with boundary conditions

$$(23) \quad p_i(T) = -C_i$$

i.e., equivalent with  $C_i$  from 21.

Then the Hamiltonian function is defined as:

$$(24) \quad H[x, u, p] = \sum_{i=1}^n p_i(t) \dot{x}_i = \sum_{i=1}^n p_i f_i(x_1 \dots x_n, u_1 \dots u_m, t)$$

$H$  is maximized with respect to  $x$ ,  $u$  and  $p$  and from the system:

$$(25) \quad \frac{\partial H}{\partial x} = 0, \quad \frac{\partial H}{\partial u} = 0 \text{ and } \frac{\partial H}{\partial p} = 0$$

the  $u(t)$  is found which maximizes  $x_{n+1}$

To illustrate the principle a simple multiplier problem is presented below.

The first step is to work out the problem incorporating only stability criteria and then extending it to include optimality criteria.

The model<sup>9</sup> is [1, p.72].

$$(26) \quad Y_d = (1-s)Y + I + G + A$$

Equation 26 defines the demand side

$$(27) \quad I = v \frac{dY}{dt} - k \frac{dI}{dt}$$

27 introduces the feed-back into the system

$$(28) \quad \frac{dY}{dt} = -\lambda(Y - Y_d)$$

Finally 28 defines the supply side of the model.

The stability criteria is:

$$(29) \quad G = -f_p Y$$

i.e., government expenditures vary with national income.

Solving the system of 26, 27, 28 and 29:

$$(30) \quad \frac{1}{\lambda} \ddot{Y} + (s + \frac{k}{\lambda} - kv) \dot{Y} + ksA = kA$$

The solution of 30 gives

$$(31) \quad Y_t = B e^{r_1(t)} + C e^{r_2(t)}$$

where  $r_1$  and  $r_2$  are functions of  $f_p$ .

The expansion path of 31 can be controlled by controlling  $f_p$ .

31 gives a stable path for  $Y(t)$  but not an optimal one.

To incorporate optimality a performance integral is introduced of the form:

$$(32) \quad \text{Min } W = \int_0^T [a_1 (Y - Y^*)^2 + a_2 (G - G^*)^2] dt$$

32 gives the sum of deviations over time  $T$ , of the actual values of  $Y$  and  $G$  from their desired ones  $Y^*$  and  $G^*$  and for that reason is minimized. To simplify the problem the desired values  $Y^*$  and  $G^*$  can be taken as zero. The function to be minimized is then

$$(33) \quad \text{Min } W = \int_0^T [a_1 Y^2 + a_2 G^2] dt$$

Subject to:

$$(34) \quad \dot{Y} = -s\lambda Y + \lambda G + \lambda A$$

which is the differential equation that gives the solution of a multiplier model [1, p.69].

To solve this problem the following functions are defined:

$$(35) \quad \dot{Y} = \dot{x}_1$$

$$(36) \quad W = x_2 \text{ and } \dot{W} = \dot{x}_2$$

The system becomes

$$(37) \quad \dot{x}_1 = -s\lambda x_1 + \lambda G + \lambda A$$

$$(38) \quad x_2 = a_1 x_1^2 + a_2 G^2$$

Shadow functions are now defined analogous with 22

$$(39) \quad \dot{p}_1(t) = p_1(s) - 2 p_2 a_1 x_1$$

$$(40) \quad \dot{p}_2(t) = 0$$

with boundary values

$$(41) \quad p_1(T) = 0$$

$$(42) \quad p_2(T) = -1 \quad 10 \text{ (footnote)}$$

From 40 and 42

$$(43) \quad p_2(t) = -1$$

Substituting 43 in 39

$$(44) \quad \dot{p}_1(t) = \lambda s p_1 - 2 a_1 x_1$$

The Hamiltonian is now defined

$$(45) \quad H(G, p, x) = \sum_{i=1}^2 p_i \dot{x}_i$$

or

$$(46) \quad H = s\lambda p_1 a_1 + \lambda p_1 G + \lambda p_1 A + a_1 p_2 x_1^2 + a_2 p_2 G^2$$

The optimum path for  $G(t)$  is found from  $\frac{\partial H}{\partial G} = 0$

$$(47) \quad \frac{\partial H}{\partial G} = [\lambda p_1 + 2 p_2 G] = 0$$

or

$$(48) \quad G^0 = -\frac{\lambda p_1}{2a_2 p_2(t)} = \frac{p_1(t)}{2a_2}$$

Substituting 48 in 34, and using 44, the new system to be solved, becomes:

$$(49) \quad \dot{x}_1 = -s\lambda x_1 + \frac{\lambda^2}{2a_2} p_1 + \lambda A$$

$$(50) \quad \dot{p}_1 = -2a_1 x_1 + \lambda s p_1$$

$$(51) \quad p_1(T) = 0$$

The general form of the solution of 49, 50 and 51 is

$$(52) \quad x_1(t) = B_1 e^{r_1 t}$$

$$(53) \quad p_1(t) = B_2 e^{r_2 t}$$

Substituting 53 in 48 the optimal path of  $G(t)$  is found:

$$(54) \quad G^0 = \frac{\lambda}{2a_2} B_2 e^{r_2 t}$$

52 and 54 give the solution of the problem, that is they give an optimal path for the target and instrument variable.

In this problem no restrictions were imposed on the instrument and target variable, but if it had also been postulated that



(55)  $x_1 \in X$  and  $G \in X$

52 and 54 would have had to be limited within the boundaries.

The above presentation provided a superficial analysis of the optimality-stability problem.

### Conclusions

Having introduced in the previous sections the essential elements of quantitative economic policy (including the stability-optimality problem) the next step will be to show the applicability of those elements to actual situations. For this reason a review of applied models will be made in the next chapter.

A policy model's basic objective is to be operational either for stabilization purposes or for development planning. For these reasons two requirements must always be met in an applied model.

First the model should be able to analyse and explain the observed process of growth of an economy by means of a set of quantitative relationships so that the empirical realism of the model may be tested. Second, a number of instrument variables must be included in the model, to be used by the planner in influencing the economic process to an optimum or stable path.

In development models the attainment of optimum values, for a number of the macroeconomic variables, is the main objective and stability may at times be sacrificed. For advanced economies stability is the important issue, although a combination of stability and of optimality would have been more desirable if it were possible to incorporate both objectives in a policy model.

The optimum values in development models are established either through target variables or through the social welfare function. The problem then is to solve for values of the instrument variables consistent with either fixed values of the target variables or maximizing a welfare function expressed in terms of flexible variables.

In stabilization models the introduction of feed-back control helps in keeping the economy to a stable path, which path may not be the optimum. As it has been already demonstrated the utilization of Pontryagin's principle allows one to solve for an optimum and stable path for the instrument variables.

The next chapter will emphasize different approaches for development planning, and explore their limitations and weaknesses. A stabilization model is also included, to show, among other things, the feed-back idea in an operational framework.

## CHAPTER II

Two groups of applied policy models may be distinguished: a) stabilization models which are applicable to advanced economies and b) development models which are applicable to developing economies.

Emphasis will be mainly given here to development models, although a stabilization model will also be reviewed at the end of this chapter.

Development policy models

A brief discussion will be given of the different types of models used in development planning, i.e.:

- 1) Aggregate models which apply to the entire economy
- 2) Sectoral models which apply to individual sectors
- 3) Inter-industry models which are concerned with the interrelationship among productive sectors of the economy.

In general terms aggregate models are used to determine the rate of growth of G.N.P. consistent with available resources (savings, imports) to carry out a development program. Sectoral models are used to determine levels of production among sectors of the economy. Sectoral models are needed for the second stage of development. In other words, after the general paths of the major macroeconomic variables have been established through an aggregate model a sectoral model could show the inconsistencies of the initial solution by pointing out, for example, that the calculated (required) consumption could not be met by the agricultural sector.

Inter-industry models range from simple input-output models to



complicated linear programming ones. This type of model helps to determine a mutually consistent set of production levels for all economic sectors.

Most theoretical growth models - referring as they do to a closed economy - assume that the level of domestic savings impose the main constraint to economic growth. For this reason, most of the aggregate models are essentially of the Harrod type.

Breaking the above pattern of policy models Chenery and Bruno [5] introduced as another constraint to growth the availability of foreign exchange reserves which was necessary to study an open economy. It is clear that a desired rate of growth may be unattainable either due to a limitation of domestic savings or to a shortage of foreign reserves. Such a model may then determine the level of foreign assistance to eliminate either of the two constraints.

The variables of the Chenery and Bruno model are divided into:

- a) endogenous variables (not under the control of the policy maker),
- b) instruments and controlled variables and c) predetermined variables.

Eight of these variables are considered as policy variables and divided into four classes (which are not mutually exclusive):

Fixed targets: Government expenditures (G) and unemployment rate (u)

Variable targets: Gross national product (V); private consumption (C) and foreign capital inflow (F)

Instruments: F; marginal propensity to save (s) and effective exchange rate (r)

Institutional limits:  $F$ ;  $s$ ; and annual increase in labor productivity (1)

The importance of this classification is that it allows for certain variables to be both instruments and targets. For example,  $F$  (= foreign capital inflow) can be used as target for balance of payment purposes and at the same time can be used as an instrument for attaining a certain level of Gross National Product.

This approach also allows the introduction of limits in the range of values that some of the instruments may take. The limits express the socio-economic conditions of the country. For example, the marginal propensity to save ( $s$ ) cannot fluctuate without limits because the social and economic conditions of the country will not allow it.

The model consists of twelve equations. Seven of them are behavioral, two are definitional and three impose the limitations (capital, labor, and balance of payments) to the model.

The reduced form of the model includes four equations with eight unknowns (the policy variables). This implies that there are four policy degrees of freedom, and the reduced form gives a range of alternative solutions. The policy maker is then able to choose among several alternative solutions instead of being forced to accept one solution.

The reduced form is given in the following way

$V = f(u, 1)$  expressing the full employment equilibrium

$V = f(s, F)$  expressing the investment-savings equilibrium

$V = f(G, r, F)$  expressing the balance of payments equilibrium

$C + G = f(s, U_m)$  for welfare considerations.

This type of model can be applied to a number of countries since it incorporates the essential features of a developing economy.

### Sector models

Sectoral models are used either to determine levels of production and consumption by economic sectors or for allocating investment within different sectors of the economy. Mahalanobis [12] used a sectoral model to determine the percentage of allocation of a given level of investment among the four sectors of Indian economy. The four sectors were:

- (1) Capital good sector
- (2) Consumption good sector using advanced techniques
- (3) Consumption good sector using primitive techniques
- (4) Services

A drawback of this type of models is that it is impossible to implement, in practice, a division of investment along these lines, for two reasons: first, part of the investment going into sector (1) is for depreciation purposes and as such should be treated as consumption; and secondly, investment goods can be used either for producing additional investment goods or consumption goods making it difficult to draw clearly the distinction between investment in sector (1) and in sector (2).

Despite these unrealistic features the model will be analyzed so that the relevant elements of sectoral models could be understood.

The variables of the system are:

Y = gross national product

C = consumption

I = investment

N = employment level

$\lambda_i$  = proportion of total investment allocated to  
sector  $i$ , ( $i = 1, 2, 3, 4$ )

$\beta_i$  = output/capital ratios

$\theta_i$  = labor/capital ratios

The variables of the model are divided within Tinbergen's framework  
as follows:

Data  $\beta_i, \theta_i$  and  $I^*$

Instruments  $\lambda_i$

Targets  $Y^*$  and  $N^*$

Irrelevant variables  $I_i, N_i$

The model has twelve definitional equations

$$Y^* = Y_1 + Y_2 + Y_3 + Y_4$$

$$N^* = N_1 + N_2 + N_3 + N_4$$

$$I^* = I_1 + I_2 + I_3 + I_4$$

$$\theta_i = \frac{N_i}{\lambda_i I^*}$$

$$\beta_i = \frac{Y_i}{\lambda_i I^*}$$

$$1 = \lambda_1 + \lambda_2 + \lambda_3 + \lambda_4$$

The values of  $\lambda_i$ 's must be found consistent with the fixed target  
values of  $N^*$  and  $Y^*$  and the anticipated level of  $I^*$ .

The reduced form of the model consists of two equations with three  
unknowns<sup>11</sup>. The problem could be treated in two ways: either all three  
 $\lambda_i$ 's remain variables and so one policy degree of freedom is introduced  
or one of the  $\lambda_i$ 's is exogenously determined.



Mahalanobis chose the second alternative. He constructed a two sector model of the following form:

$$I_t = I_{t-1} + \lambda_1 \beta_1 I_{t-1}$$

$$C_t = C_{t-1} + \lambda_2 \beta_2 C_{t-1}$$

$$Y_t = C_t + I_t$$

The problem now is to solve for  $\lambda_1$  which will maximize  $Y_t$  within time  $t^{12}$ . This way a value for  $\lambda_1$  was found which was used eventually to determine  $\lambda_2$ ,  $\lambda_3$  and  $\lambda_4$ .

Mahalanobis' model aroused strong criticism for a number of its assumptions and the way that the  $\beta$ 's and  $\theta$ 's were estimated.

#### Inter-industry models

Inter-industry models vary from simple input-output models to advanced linear programming ones.

The general structure of a linear programming model is as follows: an objective function is maximized subject to a set of linear constraints which incorporate all the policy limitations.

The constraints are of different types: a) the economy cannot use more than its available supply of productive capacity, labor, foreign exchange, and savings; b) in each sector (or industry) a minimum level for investment and domestic consumption is established. Additional constraints may be added to meet the particular cases.

M. Bruno [3] employed linear programming techniques in developing a multisectoral model for Israel.

The economy was divided in 30 sectors; and optimal values for the levels of output, consumption, investment, exports and imports by sector

and by type of commodity group as well as the prices of commodities and primary factors are sought.

The objective function of the model maximizes total private consumption at the end of the planning period subject to a number of constraints.

The constraints are imposed by:

- a) Output determination
- b) Demand for investment goods
- c) Demand for imports
- d) Export constraint
- e) Foreign exchange constraint
- f) Labor constraint

The demand for investment goods was determined through capital-output coefficients. Import requirements were determined through a set of import coefficients for each sector and type of final good. Labor coefficients were projected on the basis of past experience and were used to determine the demand for labor. For exports two values were used: a) a minimum based on the 1964 level and b) a maximum based on past performance and export advice. Consumption was determined by expenditure elasticities.

The essential limitations are imposed on the model by the supply of foreign exchange and of labor. In this respect a set of solutions is found by fixing the values of all the exogenous variables and varying either the foreign capital inflow ( $F$ ) or the supply of labor ( $L$ ).

#### A stabilization model

In contrast with the previously discussed models the model to be reviewed next is strictly a stabilization model applying exclusively to the fiscal sector of the United States during a recession [6].

The main objective is to measure the performance of the built-in stabilizers (taxes and transfer payments) and to investigate the possibility of improving the stability of the system by introducing more effective stabilizers.

The model is built around the following relationship

$$Y_d = G.N.P. - T - T_r - E_e$$

where

$Y_d$  = disposable income

G.N.P. = gross national product

$T$  = taxes

$T_r$  = transfers

$E_e$  = gross retained corporate earnings.

Equations are then constructed to explain each one of the above variables and in addition, a consumption and inventory function are introduced. As explanatory variables, G.N.P. and its components, population and other autonomous variables are used.

The model is of a dynamic and recursive nature. The essential characteristics of a recursive system were already explained in the previous chapter.

The automatic stabilizers operate as feed-backs as it is shown on Diagram 1.

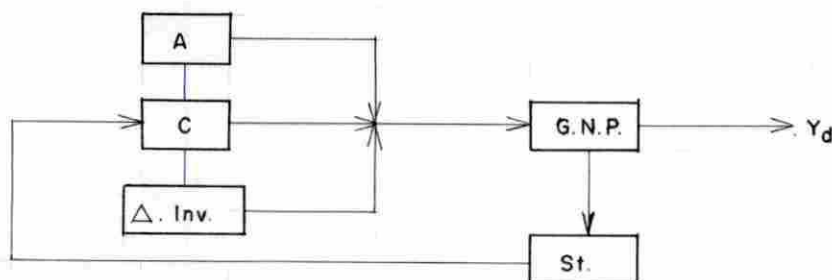


Diagram 1. Block diagram for the stabilization model

Where

$A$  = autonomous expenditures

$C$  = consumption

$\Delta \text{Inv.}$  = changes in inventory investment

$S_t$  = stabilizers

The input to the system is the sum of  $A + C + \Delta \text{Inv.}$  and the output is  $Y_d$ .

The output can be controlled to a desirable level by the stabilizers.

Assume that a decline in  $A$  is recorded at time  $t$ . Then G.N.P. and  $Y_d$  will decline and since  $C = f(Y_d)_{t-1}$   $C$  will also decline at  $t + 1$ . The existence of stabilizers does not allow the last step to take place because the decline of G.N.P. at  $t$  creates a compensatory movement in the stabilizers such as to increase transfer payments and decrease taxation and as a result alleviate considerably the decline which would have taken place in  $Y_d$  otherwise. As a consequence  $C$  at  $t + 1$  remains quite stable instead of falling.

The above compensatory mechanism results in making the system very stable and capable of reacting to strong "shocks". This last statement does not of course imply that recession is eliminated but that it is essentially shortened.

The model is also used to test alternative fiscal policies. This is accomplished by changing some of the tax and transfer equations in order to correspond to potential policy changes. As an example personal income tax collection is tied to variations of G.N.P. rather than to unemployment rates.

$$T' = cT$$



where

$T$  = taxes collected under the regular tax system

$$\alpha = 1 - f\left(\frac{G.N.P._t - G.N.P._o}{G.N.P._o}\right)$$

The proportional taxation is a strong policy measure and reduces the instability of the system considerably.

The interesting conclusion is that neither the actual automatic stabilizers nor the actual policies tested have the ability to bring the economy to full employment.

The reason for this inadequacy is that all stabilizers discussed in the model are of proportional type. In Phillips work [15] two additional forms of stabilizers are introduced:

The integral stabilizer which has the following form

$$T' = \alpha_1 \int_0^t T \, dt$$

where

$$\alpha_1 = 1 - f\left(\frac{GNP_t - GNP_o}{GNP_o}\right)$$

i.e., the collected taxes will be the cumulative total of the change in the rate of G.N.P. Such a policy will introduce violent fluctuations and a derivative stabilizer must be introduced to correct the oscillations, i.e.,

$$T' = \alpha_d \frac{dT}{dt} \quad \alpha_d = 1 - f\left(\frac{GNP_t - GNP_o}{GNP_o}\right)$$

A combination of all three forms will give almost perfect stability, which may be undesirable after all.

The model that will be formulated in the next chapters is based on Thorbecke and Condos macroeconomic models for Peru [21].

Thorbecke and Condos formulated three alternative macroeconomic models for the Peruvian economy to be used in, among other things, "first, to describe quantitatively the growth of the Peruvian economy over the period 1950-1964, second, to project the future path of major macro-economic variables..." [21, p.1].

This type of aggregate models allows one a) to describe the quantitative paths of the major macroeconomic variables over the past sample period, b) to project the future paths of those variables and c) to derive certain values for the set of instruments which will permit the attainment of predetermined targets.

The drawback both of the Peruvian models and the one to be presented next is that they are demand-oriented, since no production function is included, and therefore only valid in the short run.

From the three Peruvian models the most interesting is model C, in which the public sector has been included, allowing for the introduction of policy variables available to the government.

In the reduced form of model C the twelve endogenous variables are explained by the following eight endogenous variables.

(a) potential instruments

$s^G$  = ratio of public income from domestic sources allocated to  
public investment

$F$  = net inflow of foreign public investment

$R$  = net revenue (or expenditure) from non-tax, non-foreign  
source

(b) other data

$\frac{\Delta}{\Delta K} \frac{m-1}{-1}^{2m}$  = capacity index. Ratio of annual change in imports of raw materials, fuels and services, lagged one year, to net investment lagged one year

$E_{-1}$  = total exports of goods and services lagged one year

$Z_{-1}$  = terms of trade effect lagged one year

$E$  = total exports of goods and services

$Z$  = terms of trade effect

The most important instrument is  $s^g$ . In symbols  $s^g = \frac{I^g - F}{X^g - F}$

where  $I^g$  = government investment and  $X^g$  = government gross domestic income.  $s^g$  can be varied, within certain limits, by the policy maker depending on the  $F$ . In other words if a high amount of  $F$  can be obtained from abroad then the amount of domestic resources to be spent for government investment can be reduced.

Using these instruments (i.e.,  $s^g$ ,  $F$  and  $R$ ) the influence of alternative government actions can be observed upon the major targets.

The model that is presented next, is a modest attempt at formulating an aggregate model to describe the growth of Argentina's economy over the period 1950-1964. Lack of data and the explosive inflation that Argentina is still going through did not permit the construction of a complete model i.e., one that could also be used for macroeconomic projections.

## CHAPTER III

Argentina's economic history

The steps that must usually be taken in deriving an econometric model for any country are:

- a) A thorough study of the economy
- b) A theoretical model appropriate to describe the structure of the economy
- c) Formulating and specifying empirically the above model.

In the next section a brief economic history of Argentina will be given dividing it into three phases, [24,25,26,27,30].

The first phase includes the years 1900-1932, i.e., from the beginning of the century up to and including the great depression; the second phase covers 1932 to 1946, i.e., up to the end of the second world war and the third spans the period from 1946 to 1965.

The first phase

The first three decades of the present century found the country expanding its domestic product at an cumulative annual growth rate of 4.5 percent, a rather remarkable rate. Yet, because of heavy immigration the per capita product grew by only 1.2 percent annually. Even to maintain this modest increase, a substantial amount of investment was needed since in the early years of the present century Argentina had a rather insignificant domestic industry. To meet a growth rate of 4.5 percent Argentina was investing 31.6 percent of its G.D.P., a relatively high ratio. The economy was heavily dependent on agricultural exports, most of which were going through an industrial process. This process had



significant dynamic effects for the rest of the industrial sector, allowing an industrialization in depth.

During 1914-18, due to the war, some of the imported goods were in shortage, and as a result an intensive "import substitution" industrialization was undertaken, which was especially successful in consumer manufacturing. Imports of such goods declined further and the balance of payments situation for Argentina became extremely favorable and enabled her to expand her industrialization into other areas, such as engineering.

Nevertheless, there was a structural disequilibrium in the economy. For some commodities the domestic demand was very low in comparison with domestic production, while for other commodities the domestic production was insignificant.

Such an economy could only grow in a stable way if foreign trade continued to expand; i.e., only if national incomes in the rest of the world continued to rise, so that to act as a stimulus to the domestic economy through the foreign trade multiplier.

The need for a continuous expansion of foreign trade was shown to be desirable for Argentina with the world depression of 1929. At that time it became apparent that there was a dramatic need for industrial imports which could no longer be financed, since exports had declined considerably (because of the decline in incomes abroad) together with the inflow of foreign investment.

In quantitative terms, the decline in foreign exchange reserves forced imports to decline by more than 50 percent in the years 1929-1932.



### The second phase

From among the different policy alternatives available to Argentina to meet the delicate situation, the most realistic was chosen: high internal demand (to avoid stagnation) was maintained, which was followed by attempts at keeping the level of unemployment low. To achieve the latter an intensive expansion of the domestic industry in other than consumer manufacturing had to be undertaken.

Fortunately, enough incentives were created to fulfill the plan: selective import controls, tariff increase, and devaluation enabled the industrial sector to expand considerably.

The socio-economic unity that Argentina had achieved by the end of the nineteenth century also helped in reallocating the resources successfully. Some additional reasons for the success of the plan were: 1) the decline in exports released enough foodstuff to be consumed at home so prices remained constant; 2) Argentina at the time of the slump had a substantial excess (industrial) capacity, and 3) there was a very significant amount of social overhead capital, especially in transportation and power, which facilitated the creation of new industries and markets.

On the whole, the transformation of the Argentinean economy during the thirties was from an externally directed one to a more balanced one, but still heavily dependent on exports for financing the capital goods and raw materials needed for further economic expansion.

By the end of the thirties, exports started rising again. A new problem was created: imports were hard to get. Industrial Europe was

not able to supply what was needed, and at first the U.S. was sought as an alternative. But the entrance of the U.S. into the war, the transformation of its industry to meet the war requirements limited considerably its ability to export industrial materials. As a result Argentina's production could not expand, and inflationary forces started operating again. While inflation was rather mild, the import limitation revealed other weaknesses in the system. During 1943 substantial shortages in fuel and electric power were observed, and the transportation system (especially railways) was collapsing. This was due to the negligence during the thirties in replacing or expanding the two sectors.

#### The third phase

In the course of the two last decades Argentina's economy underwent two drastic structural changes.

It is interesting nevertheless to note that although fundamental changes took place the main goal remained the same, namely: industrialization.

It is furthermore interesting to note that the policies to attain this goal remained essentially the same during the whole period under study. This last phenomenon can be explained by the fact that after 1949 policy alternatives were limited by the following:

- 1) a continuing deterioration in the terms of trade
- 2) the rigidity of agricultural supply
- 3) the competition of domestic consumption with overseas demand  
for the available supplies of exportable goods, and
- 4) the growth of industries requiring large inputs of imported

goods [29, p.357].

It may be useful for understanding clearly why Argentina's economy evolved as it did from 1945 on, to see the prevailing attitudes in the country toward industrialization.

Industrialization took the form of import substitution of consumption goods. The rationale to the above strategy was the assumption that the industrially-advanced countries would be concentrating on the production of capital goods, as a result of their war efforts, leaving thereby the consumer market open for other nations.

This seems to be the basic principle upon which the first five year plan was drawn. It is not an exaggeration to say that this principle created the problems that Argentina has been facing since 1949.

The policies undertaken to combat inflation varied between the pre- and the post-1955 regime. Peron's government was rather passive about inflation. After 1955 the government attempted to combat inflation more through tax policies, but usually unsuccessfully.

The period from 1945 to 1963 can be divided either on the basis of policies undertaken to combat inflation or according to G.N.P. movements.

The second breakdown will be selected here since the model is of an aggregate nature. It will become clear nevertheless that at times stabilization policies affected the real output movement.

The six periods are:

- a) 1945-1949
- b) 1950-1952
- c) 1953-1958

- d) 1959
- e) 1960-1961
- f) 1962-1963

#### 1945-1949

This period will be analyzed in detail since what happens after 1949 is an attempt to correct the structural imbalances that were created during the period 1945-1949.

The main feature of this period is a general economic expansion with real per capita income increasing at the rate of 6.9% per annum. Industry was accounting for 30.3% of G.N.P. in 1945-1949, in comparison with 27.5% in 1940-1944. On the other hand, agricultural participation in G.N.P. declined from 24.7% in 1940-1944 to 18.5% in 1945-1949. These two movements created an unbalanced economy and also initiated the post 1949 inflationary trends and stagnation.

When in 1945, industrialization became the explicit goal of the country, Argentina was in a favorable position in the international market. The terms-of-trade were moving upwards and ample reserves had been accumulated during the war years. These two factors combined, allowed for a high capacity to import with which an industrialization plan could be implemented.

The decline of agricultural output was thought as a necessary evil if industrialization was to take place. This notion was based on the theory that a high rate of industrialization requires, among others, a high rate of increase in the industrial labor force, meaning a reduction in the agricultural labor force, resulted in a decline in agricultural



output.

A decline in agricultural output is not, of course, necessary if labor productivity can be increased. To increase productivity, investment in the agricultural sector ought to have been stimulated through different incentives. The authorities, instead, did not allow agricultural prices to move according to international trends but forced them to remain low which acted as a disincentive to investment in that sector.

Two important factors were, however, overlooked:

a) The decline in agricultural output limited the available volume of exports since 95 percent of total exports over that period were of agricultural origin, reducing thereby the capacity to import.

b) The rising industrial labor force increased the consumption of foodstuff<sup>13</sup>.

The increase in domestic consumption further decreased the available quantities for exports. Since these quantities had already been reduced by the reduction of the agricultural output the capacity to import decreased substantially<sup>14</sup>.

The ample resources and the improvement in the terms-of-trade compensated for the decline in the volume of exports and created a false impression with respect to the actual capacity to import.

In 1949 the situation changed drastically. The terms-of-trade decline for the first time and the foreign reserve reached a minimum<sup>15</sup>. The deterioration in the terms-of-trade and the elimination of the foreign reserve surplus resulted in reducing the capacity to import to such a level as to force a decline in industrial output. The further



reduction in agricultural output put additional pressure on domestic consumption and exports. The agricultural stagnation and the import limitation are responsible for the first inflationary signs that appear towards the end of 1949. The cost-of-living index rose in 1949 by 34.7 percent and forced the government to respond with some restrictive measures in the form of wage control and credit restriction and others. The problem was that: "the situation... of agricultural production in 1948 indicates the need to promote its expansion, not only because it represents an essential source of foreign exchange, but also because of the need to provide for the populations increasing consumption" [2, p.15].

#### 1950-1952

During those two years the terms-of-trade continued to deteriorate and per capita income declined.

As previously mentioned the government realized that some incentives should be given to the agricultural sector to increase output. The response of the agricultural sector to the government incentives was positive.

The inflation continued nevertheless to increase, because:

a) The deterioration in terms-of-trade and the incentives given to the agricultural sector in the form of high subsidized prices had as a result to increase the price of foodstuffs domestically and

b) a devaluation of the peso in 1952 which increased substantially the price of imported goods contributed to a rise of the price level.

#### 1953-1958

By mid 1952 a strong effort was undertaken to combat inflation. The

above mentioned devaluation was one of the measures that were undertaken. In addition, credit restriction and reduction in public expenditures resulted in a successful check on inflation. In 1953 and 1954 prices increased by only 4 percent over the previous year. The balance of payments also improved due to an excellent harvest in 1953 and reduction in imports.

The reduction of imports was caused by a decline in industrial output, a consequence of the depressionary measures mentioned above. Industry was forced to work well below capacity. In 1954 the restrictive policies were relaxed.

In 1955 Peron's regime was overthrown. Significant structural changes have taken place after 1955 but the goal remained the same: industrialization.

Since 1951 it became apparent that industrialization should also include the creation of capital good industry and an intensive exploitation of domestic raw material.

Major incentives (such as price support) were given again to the agricultural sector to increase output but without success, particularly since 1955. It is interesting also to point out that although a series of measures were undertaken to combat inflation, prices rose at an increasing rate.

Despite the adverse conditions G.N.P. rose in 1953-1958 on the average 4.9 percent per annum due to industrial development.

Although the level of exports started increasing from 1956, the capacity to import stayed rather stable, because the purchasing power

of exports remained fixed. As a result, the deficit in the balance of payments increased once again, because huge amounts of imports had to be acquired to sustain the industrial expansion.

#### 1959

During 1959 a reduction in government investment took place, which in turn, constituted the main factor in the decline of the G.N.P. by 4.9 percent.

#### 1960-1961

In contrast, during the next two years heavy investment was undertaken in the capital goods sector which resulted in bringing the G.N.P. to its highest level for the whole period under discussion. This process of heavy investment had two drawbacks which intensified the rate of inflation:

a) The excessive investment (its coefficient rose in relation to G.N.P. from 18.8 percent in 1958 to 23.5 percent in 1961) limited the availability of resources for real consumption, so personal per capita consumption declined in 1959-1960. This, of course, resulted in intensifying inflation.

b) Imports had to be increased, so that the investment could be met, and since exports did not increase in the same proportion, the current account showed huge deficits.

It must be said, however, that important changes took place in the Argentine economy as a whole, such as the considerable increase of domestic energy supply due to self sufficiency in domestic production of fuels, (by 1963 only 5.8 percent of total imports were imported

compared with a 24.4 percent in 1950).

It must be noted here that apart from the agricultural stagnation and the resultant decrease in the capacity to import, energy and transport were in very short supply during the whole period and played an important role in limiting the expansion of G.N.P.

In 1962-1963 there was a considerable decline of the G.N.P. It is too early to explain the cause for this decline, but one of the main reasons might be the measures undertaken in 1958 and drastically enforced in 1962 and 1963 for controlling inflation and relieving the pressure on the balance of payments.

At the same time, since import substitution opportunities are virtually exhausted in consumer goods, the G.N.P. can expand only with the expansion of domestic demand and increase in exports.



## CHAPTER IV

A theoretical model

An attempt will be made to formulate a theoretical model capable of explaining the events described in the preceding chapter.

A number of simplifications will be made which will allow:

- a) A better description of the situation (process) over the sample period, and
- b) A better insight into what happened, without violating the underlying reality.

The task is made quite difficult because of the incorporation of both structural imbalances and inflation.

An attempt will be made to show, with the help of the model, that structural imbalances were the cause of the present situation in Argentina and that, furthermore, these structural imbalances were the result of earlier misguided economic policies.

Features and assumptions underlying the modelList of symbols

- $V_T$  = total output
- $V_A$  = agricultural output
- $V_B$  = industrial output
- $C_A$  = consumption of agricultural commodities
- $C_B$  = consumption of industrial commodities
- $E_A$  = exports of agricultural commodities
- $M$  = imports of capital goods and raw materials
- t.t. = terms-of-trade



The following relationships are postulated. The economy is divided into two sectors:

The (A) subscript refers to the agricultural sector

The (B) subscript refers to the industrial sector.

$$(56) \quad V_T = V_A + V_B$$

The output of sector A ( $V_A$ ) is either consumed domestically ( $C_A$ ) or exported. In the model it is assumed that all exports are of agricultural origin (i.e.,  $E_A$ ). In fact as can be seen in Table 1 the above assumption is not extreme since about 90 percent of total exports were of agricultural origin during the period under consideration.

$$(57) \quad V_A = C_A + E_A$$

The output of sector B ( $V_B$ ) is totally consumed domestically:

$$(58) \quad C_B = V_B$$

The consumption of agricultural commodities is lineary related to total output

$$(59) \quad C_A = a + b V_T$$

Exports ( $E_A$ ) are assumed to be endogenously determined within the system on the basis of 60 to be explained below.

$$(60) \quad E_A = c + d V_A - e C_A$$

In 60 it is assumed that  $e > d$ . The importance of this assumption is that despite an increase in  $V_A$ ,  $E_A$  may ultimately decline as is discussed subsequently.

The consumption of industrial goods ( $C_B$ ) is a linear function of total output

$$(61) \quad C_B = g + h V_T$$

Furthermore it is assumed that the output of sector B can only expand as a function of imports of capital goods and raw materials. In a sense to be specified below, it is postulated that other resources (i.e., labor) can only be combined with imports in fixed proportions.

$$(62) \quad V_B = n + m M$$

Finally, the capacity to import is defined as:

$$(63) \quad M = t.t. + E_A$$

These eight equations will be used to describe what happened to Argentina from 1945 to 1963.

The primary target of the government during that period appeared to be the expansion of industrial output at a rate faster than that of agricultural output. As specified in 62 the increase in the output of sector B depends on the availability of imports which in turn is limited primarily by  $E_A$  and by the terms-of-trade. The industrial expansion will also require the reallocation of factors of production (labor and capital) from the agricultural to the industrial sector.

The fluctuation in the terms-of-trade have been of extreme importance in determining the capacity to import, particularly since, for reasons to be discussed later,  $E_A$  first declined and then remained essentially at the same level over the period under consideration.

This is why the terms-of-trade will be used as the "pivot" variable in analyzing the period 1945-1963 for Argentina.

The analysis will be conducted in two parts. First the behavior of the economy will be examined under conditions of improving terms-of-trade. It will be seen that an improvement in the terms-of-trade may create

illusions about the actual capacity to import.

The second part will be concerned with what happens when a worsening in the terms-of-trade occurs subsequent to a period of improving terms-of-trade. In fact the above distinction corresponds to the actual course of the terms-of-trade in Argentina during the postwar period.

#### Improvements in the terms-of-trade

When terms-of-trade are improving the capacity to import is rising, 63. The rise in the capacity to import will result in expanding the output of sector B, 62. The increase of  $V_B$  will necessitate a reallocation of resources from sector A to sector B. The withdrawal of factors of production from sector A will necessarily reduce its output<sup>16</sup>.

From 57 it may be observed that the decline in  $V_A$  implies a reduction in  $C_A$  or in  $E_A$  or in both. On the other hand an increase in  $V_T$ , assuming that  $V_B$ 's growth is greater than  $V_A$ 's drop in output, will result in a rise in the demand for  $C_A$  and  $C_B$  (from 59 and 61).

Now the two problems that are created by such a process can be observed separately.

#### 1) Relationship between exports and imports

Equation 62 requires a rise in  $M$ , which was assumed to have resulted from improved terms-of-trade for the expansion of  $V_B$ . However the decline in  $V_A$  and the rise in  $C_A$ , discussed above, will reduce the available volume of exports ( $E_A$ ) as can be seen from 57. This last movement will create a gap in the balance of payments (from 63). The balance of payments disequilibrium can be avoided to the extent that the improvement in the terms-of-trade are contributing more to the capacity to import than

the decline in exports<sup>17</sup>. In this sense the growth rate of sector B becomes a function of both the terms-of-trade and  $E_A$ . In fact what happened in Argentina, over the relevant period (i.e., 1945-1949), was that the capacity to import increased.

The sequence of events discussed above can be seen in Diagram 2.

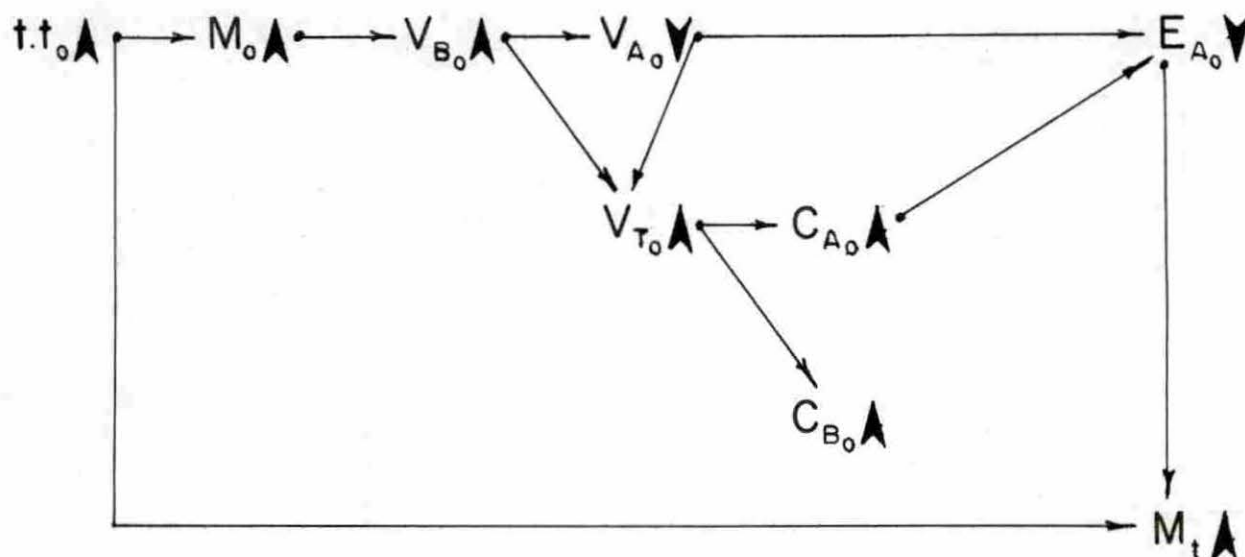


Diagram 2. Sequence of events when terms-of-trade are increasing. The subscript (o) denotes initial time reference while subscript (t) denotes any subsequent time. (1945-1949)

## 2) Relationship between agricultural and industrial sectors

The reduction in  $V_A$  and the increase in  $C_A$  will result in an increase of the price level for  $V_A$  relative to the price level for  $V_B$ <sup>18</sup>. This price movement may bring about two results:

- a) An increase in the rate of output of  $V_A$  depending on the elasticity of supply.
- b) A rise in the price level of sector B (i.e., an inflationary movement caused by the impact of  $V_A$  prices on  $V_B$  prices).



Since it has been already assumed that the supply of A is price inelastic higher prices in A will result in a rise in the cost of living in the following way.

a) The upward movement of the price level of sector A will result in an increase in food prices.

b) Labor will demand higher wages to compensate for the increase in food prices.

c) As a result of (b) industry will have to increase its prices in order not to reduce the profit margin.

In other words, excess demand inflation in sector A triggers cost inflation in sector B.

In summary if the terms-of-trade are improving, an expansion of sector B is possible without external disequilibrium but with a substantial internal price increase and a serious domestic structural disequilibrium.

This process cannot continue for a long time, because the domestic price increase will cause a decline in the demand for exports ( $E_A$ ) and eventually create an external disequilibrium.

In fact, the disequilibrium in Argentina after 1949 - to be discussed in the next section - was actually due to a decline in the terms-of-trade rather than domestic inflation.

#### Deterioration in the terms-of-trade

Things change very rapidly if the terms-of-trade start moving in an adverse way after a period of substantial improvements.

The decline in the terms-of-trade accompanied by a decline in the



volume of exports (the last one for reasons explained in the previous section) will decrease substantially the capacity to import (from 63) and this will result in limiting the expansion of sector B (from 62).

To increase the capacity to import two alternatives are offered:

- a) Improving the terms-of-trade.
- b) Increasing the output of sector A so as to increase the availability of exports ( $E_A$ ).

Both alternatives were attempted in Argentina from 1949 on but without much success for reasons to be explained presently.

An additional point should be made here. Argentina continued to import sufficient quantities of M so that the output of sector B would not decline. This was accomplished by short term loans from abroad which at the end accentuated the external disequilibrium problem, since neither  $E_A$  nor the terms-of-trade showed any improvement.

Alternative (a) may be accomplished by depreciating the value of the currency. This policy may create additional problems because it will increase the price of imports of raw materials and capital goods and as a result will force prices of sector B to move upward. Exports on the other hand may be stimulated with the improvements in the terms-of-trade. For reasons already discussed in the previous section, and for some additional ones to be discussed next,  $V_A$  declined and  $C_A$  increased causing a limitation to the available volume of exports ( $E_A$ ).

Assume that somehow it becomes possible to expand the output of sector A<sup>19</sup>. The expansion of  $V_A$  with no decline in  $V_B$  will result in an increase of  $V_T$  (from 56), which will cause  $C_A$  to rise (from 59). The

upward movements of  $C_A$  and  $V_A$  may result in a decline of  $E_A$  if  $e > d$  in 60. To see what exactly happens substitute 57 in 60

$$(64) \quad E_A = c + d V_A - e(V_A - E_A)$$

or

$$(65) \quad E_A = \frac{1}{1-e} [c + (d - e) V_A]$$

Taking the derivative of 65 with respect to  $V_A$ :

$$(66) \quad \frac{dE_A}{dV_A} = \frac{1}{1-e} (d - e)$$

Since it is assumed that  $e > d$ ,  $\frac{dE_A}{dV_A} < 0$  which implies that despite the increase in  $V_A$   $E_A$  declines.

The deterioration in the terms-of-trade will thus cause a severe external problem, and with the already existing internal disequilibrium, inflation becomes very strong.

The adverse movement in the terms-of-trade may also directly intensify inflation. This can be explained on the basis that a fall in the terms-of-trade produces a decline in the absolute value of real income [13, p. 189]<sup>20</sup>. A decline in G.N.P. creates usually a situation in which all social groups attempt to maintain their relative shares of national income at the same level as previously. This will result in a price wage increase which means inflation.

This model describes accurately the 1946-1963 period. Inflation is still present in Argentina despite the drastic measures that have been undertaken. It can be inferred from the model that only through internal structural changes will Argentina be able to solve its external

structural problem.

### Statistical evidence

In this section statistical evidence will be provided describing the course of the major macroeconomic variables in Argentina over the last fifteen years to justify the use of the previously presented theoretical model.

All the presented informations are taken from [30].

Table 1 presents the composition for exports in Argentina from 1951 to 1963. With this table it is possible to verify the following related assumptions.

- a) That output of the industrial sector is domestically consumed.
- b) That exports originate exclusively in the agricultural sector.

It is clear that agriculture contributed on the average over 90 % of the total exports. Of course, a certain percentage of the agricultural exports went through an industrial process but the amount is insignificant.

Table 2 describes very accurately the most essential features of Argentina's import structure during this period. The almost negligible amount of imports of consumer goods implies that the domestic production could meet the domestic demand by 1953 which justifies the other assumption that of a consumers goods oriented industrialization. By 1963 the share of consumer goods imports had become very small in contrast to the shares of raw material and capital goods.

It was postulated in the model that an intense industrialization will a) reduce output of the agricultural sector (since labor and capital will be withdrawn and productivity will not increase), b) decrease

Table 1. Composition of exports in millions of U.S. dollars

Year	Total	Agricultural	% Ag./Tot.
1951	1169	1100	94
2	687	633	92
3	1125	1060	94
4	1026	980	95
5	928	873	94
6	943	888	94
7	974	903	93
8	993	950	96
9	1009	965	96
1960	1079	1028	95
1	964	904	94
2	1216	1149	94
3	1365	1191	87



Table 2. Composition of imports (in percentages)

Year	Fuel	Consumption	Raw Material	Industrial
1953	24.4	7.5	41.9	26.2
4	18.4	8.9	53.0	19.7
5	17.3	7.2	55.0	20.5
6	22.3	7.3	46.6	23.7
7	24.2	5.7	47.4	22.7
8	20.5	5.4	52.9	21.2
9	21.3	3.3	52.5	22.9
1960	12.4	4.2	51.3	32.1
1	8.9	4.8	58.8	27.5
2	6.7	4.7	50.9	37.7
3	5.8	4.7	50.9	38.5

exports as a result of (a), c) increase imports, and d) will improve the internal terms of trade (i.e., the ratio of the price of agricultural goods to the price of industrial goods) in favor of industrial goods.

Looking at Table 3 two periods in Argentina's postwar economic history can be distinguished: a) from 1944 to 1948 inclusive, when the terms-of-trade were moving upwards and b) from 1949 to the present during which period the terms-of-trade worsened.

During period (a) the internal terms-of-trade were moving in an opposite (column A) way causing agricultural output to decline (column C). The decline in agricultural output caused exports to decline (column E).

Table 3. Indexes of: external and domestic terms-of-trade, industrial and agricultural output, and exports and imports

Year	Internal <sup>a</sup>	External <sup>b</sup>	Agricultural Output <sup>c</sup>	Industrial Output <sup>d</sup>	Exports <sup>e</sup>	Imports <sup>f</sup>
1944	84.6	84.6	129.9	120.8	99.3	102.6
5	101.6	87.7	104.0	113.2	99.2	104.3
6	122.6	120.3	180.7	130.7	115.0	191.3
7	106.5	143.8	154.0	151.1	107.9	381.5
8	100.9	141.7	157.7	158.2	40.9	388.3
9	91.3	117.8	126.0	157.4	67.8	274.2
1950	100.0	100.0	108.0	152.4	93.5	234.7
1	111.3	109.5	122.6	150.7	73.7	268.1
2	113.2	75.2	99.6	137.4	49.3	195.5
3	128.2	100.0	173.9	130.3	83.1	153.3
4	111.3	90.0	148.7	147.4	89.4	207.5
5	104.0	88.0	152.4	167.1	78.5	246.5
6	116.0	76.0	155.3	154.8	85.7	226.5
7	125.0	72.5	177.7	157.6	92.5	255.9
8	130.0	76.6	202.9	165.6	99.3	267.1
9	147.0	80.0	196.2	145.6	101.9	231.0
1960	145.0	84.5	188.9	155.4	101.9	280.8

<sup>a</sup>Internal terms-of-trade: the ratio of the price of agricultural goods to the price of industrial goods (1950=100)

<sup>b</sup>External terms-of-trade: the ratio of the price of exports to the price of imports (1950=100)

<sup>c</sup>Index of agricultural production (1943=100)

<sup>d</sup>Index of industrial production (1943=100)

<sup>e</sup>Index of the volume of exports (1943=100)

<sup>f</sup>Index of the volume of imports (1943=100)

Industrial output during the same period increased substantially causing an increase in the volume of imports (columns D and F).

The gap in the balance of payment was met up to 1949, through improvements in the terms-of-trade (column B).

In 1949, when period (b) starts, the terms-of-trade start declining and by 1950 it became necessary to give incentives (such as price support) to the agricultural sector.

Agricultural output kept on increasing from 1950 to 1958 while exports remained at the same level implying that domestic consumption was receiving the bulk of the increase in output (in the model this was expressed as  $e > d$  in 60).

With increasing imports<sup>21</sup>, stable exports and declining terms-of-trade, it followed that Argentina would suffer from a continuous balance of payments deficit.

Having formulated a theoretical model and having seen that it explains, in a general sense, the structure of Argentina's economy an econometric model is constructed within this framework in the next chapter.

## CHAPTER V

The estimated model

The relations that are usually included in an aggregate model are:

- 1) Consumption - income functions
- 2) Production functions relating output, with labor and capital inputs.
- 3) Import functions
- 4) Public sector functions
- 5) Identities and definitions

Because of statistical limitations, no production function was estimated. An investment function is specified instead.

An export function is also added since the assumption has been made that exports have been influenced by domestic conditions, endogenous to the system, and not by external conditions, which are usually exogenously influenced.

The existence of multiple change in tax rates, deductions and evasions, and lack of a number of statistical informations made impossible to estimate a tax function. Nevertheless, taxes were inserted as an exogenous variable.

The model incorporates six behavioral equations and seven identities.

Data

The available statistical information for Argentina is limited. The lack of information is particularly felt in the area of labor statistics. The only time series available in this area were: a) the economically active population, and b) man hours-work in the industrial sector and



specifically for the Buenos-Aires area.

Likewise capital-stock figures for the recent past were not available. The lack of data on labor and capital inputs made it impossible to incorporate a production function in the model.

In the public sector the data situation was made very difficult because of mutually inconsistent information. Table 4 presents the public sector statistical information which are based on Table 10 of [17, p.34].

Table 5 contains the underlying statistical information over the period 1950-1963 for the macroeconomic variables appearing in the model constructed below. The data is expressed in millions of 1960 pesos with the exemption of V which is an index (1960=100). As sources the [17] and [30] were used.

#### List of variables

The following variables appear in the model.

Y	= gross national product (at market prices)
$Y^{agr.}$	= agricultural income (at factor cost)
C	= total consumption
$C^P$	= private consumption
$C^G$	= government consumption
I	= gross fixed capital formation
$I^P$	= gross fixed private capital formation
M	= imports of goods
$M^i$	= imports of capital goods
$M^{rm}$	= imports of raw materials and intermediate goods

Table 4. Public sector statistics (in millions of peso at 1960 prices)

Year	A	S.C <sup>c</sup>	T	A	C <sup>g</sup>	A <sup>n</sup> 6 (4-5)	I <sup>g</sup>	K	K <sup>n</sup> 9 (8-7)	S.C <sup>a</sup>	Y <sup>g</sup>	P 12 (-11+10+9+6)	L
	1	2	3	4	5		7	8		10	11		
1950	116900	34500	151400	95700	67900	27800	41500	57500	16000	12300	2900	53200	+11200
1	125400	33500	158900	95500	68800	26700	41500	51800	10300	11600	-3900	52500	+3900
2	122400	32300	154700	93400	69000	24400	37300	45400	8100	13300	-2100	47900	-500
3	127300	37600	164900	104000	68200	35800	41200	47400	6200	16800	-3100	61900	+6400
4	130700	43000	173700	121100	71800	49300	37000	45300	8300	22700	-4800	85100	+20200
5	133100	42700	175800	119700	74900	44800	31600	39000	7400	28200	-6000	86400	+17100
6	156000	43800	199800	104000	78900	24200	27500	37800	10300	30800	-3200	68500	-24000
7	148800	43100	191900	96800	78600	18200	30900	47500	16600	26600	-3600	65000	-17400
8	128400	32300	160700	102000	79900	22100	46000	76600	30600	29000	-19500	101200	+66400
9	120200	27000	147200	88800	79700	9100	35800	49300	13500	28000	-3500	54100	+22400
1960	154900	32500	187400	100300	85600	14700	50100	65200	15100	32200	-800	62800	+11100
1	178500	38200	216700	117000	87400	29600	51500	71500	20000	40500	-3100	93200	+15400
2	142700	28460	171100	117900	82400	35500	43100	59000	15900	36400	-8500	96300	+50700
3	139000	32800	171800	102400	78400	24000	43600	61700	18100	35800	-6800	84700	+34900

Table 5. Macroeconomic Data 1950-1963 (in millions of peso of 1960 prices)

Year	Y 1	Y <sup>d</sup> 2(1-19)	C <sup>p</sup> 3	C <sup>g</sup> 4	I 5	I <sup>p</sup> 6	I <sup>g</sup> 7	M 8	M <sup>c</sup> 9	M <sup>f</sup> 10
1950	738584	663989	549480	67881	137830	96300	41500	100800	11995	17236
1	762998	694178	572889	68806	150479	109000	41500	95300	11721	15915
2	723395	643338	544308	68996	133819	96600	37300	70100	8271	17945
3	767640	688900	536346	68189	138714	97500	41200	62100	4633	15080
4	803958	720738	586585	71838	133253	96300	37000	69300	6135	12751
5	862601	775430	654448	74937	148421	116800	31600	84900	6122	14733
6	881411	780557	659224	79843	156334	128800	27500	78700	5716	17345
7	924546	837615	682986	78643	177541	146600	30900	91300	5202	22065
8	972088	894785	721649	79919	182548	136500	46000	93100	5048	18982
9	926404	863211	664494	79661	165727	129900	35800	88600	2890	18729
1960	980693	903577	677786	85634	227129	177000	50100	103300	4306	12869
1	1036228	943697	752963	87411	247897	196300	51500	132100	6370	11728
2	1003405	924705	695340	82354	243558	200400	43100	107700	5030	7227
3	948165	869137	645685	78399	204563	161000	43600	77100	3586	4513

Table 5. (Continued)

Year	$M^1$ 11	$M^{rm}$ 12	E 13	$F^s$ 14	V 15	$Y^f$ 16	$T^d$ 17	$Y^{agr}$ 18	$\lambda$ 19
1950	41832	29736	78400	21522	112	-1734	74595	125337	-15241
1	35546	32116	55500	8184	92	-3666	68820	133743	6108
2	24815	19067	44700	1397	50	- 895	77057	113779	1169
3	16253	25973	69500	10472	95	- 994	78740	148003	7514
4	13575	36556	74300	-1476	85	-1137	83220	147552	9895
5	17449	46706	66200	-3414	77	-1620	87171	153106	8529
6	18514	36451	77700	1584	77	-2519	100860	145751	-12055
7	20711	43096	82100	3960	79	-1757	86931	145451	- 7627
8	19770	49261	90000	-3834	87	-3486	77303	151755	- 1608
9	20182	46180	89400	10067	93	-3841	63193	150704	9496
1960	33037	52850	89300	2406	100	-4736	77116	150104	6474
1	36260	77659	81500	9590	91	-7341	92531	147552	- 3692
2	40326	54442	112900	-7430	112	-5674	78700	148403	- 9943
3	29652	39329	115700	-6916	133	-5730	81000	145451	- 6435



$M^c$	= imports of consumption goods
$M^f$	= imports of fuels
$E^g$	= exports of goods
$F^s$	= surplus in the balance of payments for services
$Y^f$	= income from abroad
$V$	= purchasing power of exports (index)
$\lambda$	= increase in stocks (includes only the increase in stocks of an important group of raw materials, especially of agricultural origin)
$S$	= gross savings
$L$	= budget deficit
$T$	= taxes
$Y^d$	= disposable G.N.P. ( $Y - T^d$ )
$T^d$	= direct taxes
$T^i$	= indirect taxes

#### Public sector

$A$	= current income
$A$	= current expenditure
$K$	= expenditure on capital
$L$	= budget deficit
$I^g$	= government investment
$C^g$	= government consumption
$S.C^c$	= contribution to social security (by the private sector)
$S.C^a$	= payment by social security
$Y^g$	= income by public enterprises

$$T = A + S.C^c$$

$$K^n = K - I^S$$

$$\Lambda^n = \Lambda - C^S$$

$$\rho = -Y_g + S.C^a + K^n + L^n$$

### The model

#### Behavioral equations

$$C^p = a_o^p + a_Y^p Y^d$$

$$C^S = a_o^S + a_1^S T + a_2^S L$$

$$E^S = a_o^e + a_{agr}^{agr} Y^{agr} + a_\lambda^\lambda \lambda$$

$$M^i = a_o^m + a_1^m Y + a_2^m V$$

$$M^{rm} = a_o^{\lambda m} + a^{\lambda m} Y$$

$$I^p = a_o^i + a_M^i M^i$$

#### Identities

$$Y = C^p + C^S + I^p + I^S + \lambda + E - M + F^S + Y^f$$

$$Y^d = Y - T^d$$

$$S = Y - C$$

$$C = C^p + C^S$$

$$I = I^S + I^p$$

$$M = M^i + M^{rm} + M^f + M^c$$

$$L = T - C^S - I^S - \rho$$

#### Endogenous variables

$$C^p, Y^d, C^S, E, M^e, M^{rm}, Y, I^p, S, C, I, M, L \quad (13)$$

### Exogenous

Data:  $P^s, Y^f, M^f, M^c, V, \lambda$  (6)

Potential instruments:  $I^s, T^i, Y^{agr}, T^d, L$  (5)

### Method of estimation

The behavioral equations were estimated by the ordinary least squares OLS method.

From a statistical point of view the OLS method is undesirable for simultaneous equations problems since it gives biased and inconsistent estimators. As an alternative the two stage least squares TSLS method can be used.

In the TSLS the jointly dependent endogenous variables are regressed on all exogenous variables and thus predicted values are used to estimate the relations [11, p.258].

The reason that this method was not used here is due to the large number of exogenous variables (ten in number) which makes the use of TSLS meaningless.

It can be noted, nevertheless, that in many cases when both methods were used, they gave similar results [21]. For this reason it was felt that the OLS method would be adequate in estimating the relations.

Problems that may arise in estimating the relations are multicollinearity and autocorrelation.

Multicollinearity is the high intercorrelation of two or more explanatory variables.

Autocorrelation is the lag correlation of a given series with itself. Autocorrelation appears quite often with times-series regression

equations, and it is usually caused by incomplete specification of the model.

The presence of autocorrelation has three main consequences:

a) The estimated parameters are unbiased but their sampling variance is larger compared with the ones achievable with a different estimation method.

b) The sampling variance is seriously underestimated and so the  $t$  and  $F$  formulas are no longer valid.

c) The predictions are inefficient due to the needlessly large sampling variable [11, p.179].

The test for autocorrelation is the Durbin-Watson test ( $D$ ) [7].

For one single independent variable (with the sample size used here) a value of  $D$  of .81 indicates significant autocorrelation at the 5% level of significance; a value  $D$  above 1.07 indicates serial independence while a value  $D$  between 1.07 and .81 yields inconclusive results. For equations with two independent variables the corresponding values for  $D$  are .70 and 1.25, respectively.

The  $R^2$  denotes the value of the coefficient of multiple determination adjusted for degrees of freedom. The standard errors of the coefficients are listed in parentheses below each coefficient:

$C^D = 166,656 + .667 Y^d$	$R^2 = .86$
(56,326) (.079)	$D = 1.39$
$C^S = 27,678 + .270 T + .139 L$	$R^2 = .65$
(11,238 (.062) (.051)	$D = 1.07$
$E = -89,194 + 1.180 Y^{agr} - 1.233 A$	$R^2 = .60$
(48,746) (.338) (.438)	$D = 1.94$



$$M^1 = -64,629 + .076 Y + 193 V$$

(16,068    (.018)    (90)

$$M^{xm} = -76,622 + .133 Y$$

(26,886)    (.029)

$$I^D = 50,878 + 3.860 M^1$$

(8,345)    (.325)

$$R^2 = .80$$

$$D = 1.42$$

$$R^2 = .70$$

$$D = 1.75$$

$$R^2 = .94$$

$$D = .73$$

### Behavioral equations

Exports: exports were made an endogenous variable, because it was felt that internal rather than external conditions are the determinant factors.

The lack of a domestic agricultural consumption series did not allow to see the effect of this factor on exports.

Among the other explanatory variables the terms-of-trade and price of exports were used but gave insignificant results.

On the other hand, the agricultural output was the important explanatory variable. This should have been expected since 90% of exports on the average are of agricultural nature. An important explanatory variable is the change in the stock of some raw materials most of which are of an agricultural nature (especially cattle stock).

The change of the cattle stock was caused by many factors some of which being influenced by government policy. During periods of shortage in cattle stock prices are rising and expansion of this type of agricultural products is stimulated. A time comes that the increase in the production operates to the detriment of prices and a fall of the latter leads to the liquidation of cattle stock and shift towards crop

agriculture. The liquidation is intensified if the government policy favors crop agriculture through high price supports, liberal credit, etc. During these liquidation periods the exports availability increases. So a decrease in the stock increases exports. For example, in 1957 the increase in exports was made possible by the liquidation of 412,000 tons of stock [27, p.110].

The fluctuation described above creates an instability in the agricultural sector which although typical of that sector create an extremely precarious situation for Argentina since they affect exports substantially. An increase in the stock will lower prices of stockpiled products and the resulting liquidation will boost exports temporarily but at the end a shortage is created which limits exports to a level lower than before. So in the period 1956-1957 the intensified liquidation increased exports but by 1958 the available stock was not enough to meet either the domestic requirements or the export demand and so exports had to decline.

It is thus of high importance that the government should employ policies to encourage a balance between crop and stock production and to alleviate violent fluctuations in the level of the stock.

#### Imports

Imports were divided into four categories.

- a) Imports of raw material and intermediate goods
- b) Imports of capital goods
- c) Imports of fuels
- d) Imports of consumption goods

The imports of consumption goods amounts, on the average, to 5

percent of total imports with a downward trend. Likewise fuel imports dropped from a 24.2 percent of total imports in 1953 to a mere 5.8 percent in 1963 and they are expected to decline further in the coming years.

The two last categories of imports (consumer and fuel) are exogenously determined. A number of alternative explanatory variables were used with insignificant results.

It is unfortunate that in the case of fuel imports no behavioral relation was found since the lack of fuel imposed one of the most important constraints to the growth of Argentina. One attempt gave the following results

$$M^F = -62,796 + 595 P^m + .015 Y \text{ with } R^2 = .46 ,$$

which implies that imports of fuels are inelastic with respect to  $P^m$ . This is fairly realistic if the balance of payment problems facing Argentina are taken into account. But such a relation is useless if the model is going to be used for projection purpose.

For consumer imports every attempt to fit a regression equation gave unsatisfactory results which should have been expected since the country has undertaken an intensive consumer substitution industrial expansion.

In the theoretical model it was assumed that the output of the industrial sector is directly related to the available imports, which (imports) were assumed to be only capital goods and raw material.

In fact imports consist mostly of these two groups (because fuel can be classified as raw material) and total output has been moving in relation to the available imports.

For raw materials, the constraints imposed by the balance of payments and the deteriorating terms-of-trade have not affected their level.

Argentina imports the amount desirable and necessary and then proceeds to balance the external payments through short term foreign loans.

In the case of imports of capital goods the purchasing power of exports is of importance. The reason for that is that at times of severe crises raw materials will be preferred (to keep the existing investment going) to capital goods. So capital goods have been influenced by the exports, i.e., by the capacity to import as is exemplified through the purchasing power of exports.

#### Investment function

The relation of private investment to import of capital goods implies that: a) the main constraint in domestic investment is the availability of capital goods which are mostly imported. This in effect indicates that the constraint to growth was imposed by the import-export gap rather than by the investment-savings gap.

A number of other explanatory variables were used without significant results. To incorporate the monetary sector into the model changes in the money supply were used but the standard error indicated a non-significant coefficient<sup>23</sup>.

#### Private consumption

The consumption of the private sector was explained by GNP minus direct taxes which is more or less disposable income<sup>24</sup>. This was done so that the effects of taxation on consumption could be incorporated.

#### Government consumption

Taxes do not only have a negative effect on GNP (by affecting disposable income) but also a positive one through their influence on



government expenditures. The overall "tax multiplier" is then the sum of the negative one, due to the private consumption and of the positive one due to the government expenditure.

To incorporate this idea on a model, taxes must be used to explain government consumption.

If in a particular case, there is a consistent budget deficit it should be expected that government expenditures are not determined solely on the basis of taxes but also on the basis of the level of the deficit.

For these reasons government consumption was explained here by taxes and the budget deficit.

There is, nevertheless, a limitation where budget deficit is used as an explanatory variable, namely, that a solution to a development problem may require an unrealistic increase in the budget deficit. To combat such a problem an inequality should be incorporated stating the upper bound of the budget deficit in relation say to GNP.

#### Reduced form

The reduced form of the system is given in a matrix form in Table 6. The system is extremely sensitive to changes in  $Y^{agr}$  and  $V$ . For example:

$\frac{\partial Y}{\partial Y^{agr}} = 3.986$  which implies that one unit change in  $Y^{agr}$  changes  $Y$  by

3.986. This high sensitivity could be explained the following way:

$Y^{agr}$  is of extreme importance to exports. Exports are needed to increase the capacity to import which in turn is the main force to expand  $Y$ .

This can be shown by finding the export multiplier:

$$\frac{\partial E}{\partial Y^{agr}} = 1.180 \quad \text{while} \quad \frac{\partial Y}{\partial Y^{agr}} = 3.986$$

Table 6. Reduced form in matrix notation

	Constant	$Y^{agr}$	$T^d$	$T^i$	L	$\lambda$	V	$I^g$	$M^c$	$M^t$	$P^s$	$Y^t$
Y	78653	3.986	-1.182	.912	.469	-.753	1868	3.378	-3.378	-3.378	3.378	3.378
$C^p$	190902	2.471	-1.352	.565	.290	-.466	1158	2.094	-2.094	-2.094	2.094	2.094
$C^g$	27678	0	.270	.270	.139	0	0	0	0	0	0	0
E	-89194	1.180	0	0	0	-1.223	0	0	0	0	0	0
$M^i$	-58652	.302	-.089	.069	.035	-.057	334	.256	-.256	-.256	.256	.256
$M^{rm}$	-66162	.530	-.157	.121	.062	-.100	248	.449	-.449	-.449	.449	.449
$I^p$	-175518	1.165	-.343	.266	.135	-.220	1289	.988	-.988	-.988	.988	.988
M	-124814	.832	-.246	.190	.097	-.157	582	.705	.295	.295	.705	.705
$Y^d$	78653	3.986	-2.182	.912	.469	-.753	1868	3.378	-3.378	-3.378	3.378	3.378
S	-139227	1.515	-.100	.077	.040	-.287	710	1.284	-1.284	-1.284	1.284	1.284
C	217880	2.471	-1.082	.835	.429	-.466	1158	2.094	-2.094	-2.094	2.094	2.094
I	-175518	1.165	-.343	.266	.135	-.220	1289	1.988	-.988	-.988	.988	.988

$$\text{so: } \frac{\frac{\partial Y}{\partial Y^{\text{agr}}}}{\frac{\partial Y^{\text{agr}}}{\partial E}} = \frac{3.986}{1.180} \text{ or } \frac{\partial Y}{\partial E} = 3.361$$

The above explains the high multiplier of  $Y^{\text{agr}}$  in all endogenous variables appearing in Table 6.

The reduced form will be used to test the performance of the model, instead of the estimated equations themselves. This way any consistent biasness can be observed.

In Table 7 the predicted values of  $Y$  and  $C^D$  are shown next to the observed ones.

The model appears to describe relatively well the paths of  $Y$  and  $C^D$  but this is not true for the rest of the major macroeconomic variables.

In the next section Theil's inequality coefficient will be employed to determine the cause of variation in the actual and estimated values of  $C^D$  and  $Y$  [20, p.31].

#### Measures of inequality

Theil's inequality coefficient is of the following form:

$$(67) \quad V = \frac{\sqrt{\frac{1}{m} \sum (P_i - A_i)^2}}{\sqrt{\frac{1}{m} \sum P_i^2} + \sqrt{\frac{1}{m} \sum A_i^2}}$$

where  $P_i$  is the predicted value,  $A_i$  the actual one and  $i = 1 \dots m$ .

The value of  $V$  varies from 0 to 1 with  $V = 0$  implying perfect prediction.

To determine the source of error, in the case that  $V \neq 0$ , the

Table 7. Actual and estimated values for Y and C<sup>p</sup>

Year	$\hat{Y}$	Y	$\hat{C}^p$	C <sup>p</sup>
1954	865117	803958	598282	586585
5	831450	862601	593050	654448
6	784126	881411	558720	659224
7	816882	924546	583823	682986
8	912513	972088	644493	721649
9	927292	926404	640964	664494
1960	976891	980693	644733	677786
1	970985	1.036228	622458	752963
2	961830	1.003405	654584	695340
3	924348	948165	665861	645685

numerator of 67 is decomposed in the following way:

$$\frac{1}{n} (P_i - A_i)^2 = (\bar{P} - \bar{A})^2 + (S_p - S_A)^2 + 2(1 - r)S_p S_A$$

where  $\bar{P}$ ,  $\bar{A}$  are the mean values of P and A, respectively.  $S_p$ ,  $S_A$  are the standard deviations of each series and r is the correlation coefficient relating the  $P_i$  and  $A_i$  series.

Defining:

$$(68) \quad V_m = \frac{\bar{P} - \bar{A}}{D}$$

$$(69) \quad V_s = \frac{S_p - S_A}{D}$$



$$(70) \quad V_c = \frac{2(1-r) S_P S_A}{D}$$

where D is the denominator of 67. If  $V_m^2$ ,  $V_s^2$  and  $V_c^2$  are divided by  $V^2$  the following relation is found

$$(71) \quad V^m + V^s + V^c = 1 \quad \text{where} \quad V^m = \frac{V_m^2}{V^2}, \quad V^s = \frac{V_s^2}{V^2}, \quad V^c = \frac{V_c^2}{V^2}$$

From 71 the source of error can be determined.

$V^m$ : is the partial coefficient of the proportion of inequality due to unequal control tendency

$V^s$ : is due to unequal variation

$V^c$ : is due to imperfect covariation

$V^m$  is undesirable since it exhibits a systematic error of overestimation ( $\bar{P} > \bar{A}$ ) or underestimation ( $\bar{P} < \bar{A}$ ). Such an error is either due to the structure of the model or to the method of estimation of the parameters. This type of error will significantly limit the use of the model for making structural changes in the system since the exact point of biasness cannot be determined due to the multiplicative structure of the reduced form.

$V^s$  is also undesirable because  $S_P \neq S_A$  will imply that essential explanatory variables have been excluded from the model (i.e., the predicted values move considerably differently from the actual ones). The mere existence of  $S_P = S_A$  is not enough to ensure that all explanatory variables have been included. What is also needed is that the  $r^2$  of the two series is high.

$V^c$  is an unsystematic error since it is caused by imperfect

correlation between actual and predicted values. It is a random error and if  $V^m = V^s = 0$ , (or close to 0) it implies that the model is a good one since there is neither biasness nor essential explanatory variables have been excluded.

The above concepts were utilized to test the two series Y and  $C^D$ . In Table 8 the results are shown.

Table 8. Measure of inequalities for the estimated series

	V	$V^m$	$V^s$	$V^c$
Y	.033	.235	.005	.760
$C^D$	.054	.510	insig.	.490

In the case of Y the variation in the actual and predicted value was a tolerable 3.3%. Most of the Y error (76 percent) was due to an unsystematic variation while 23.5 percent of the variation was due to a systematic error. The systematic error is caused by the method of estimation of the structural equations. The use of OLS method which produces biased coefficients in the case of a simultaneous equation problem, and the existence of inconclusive results for the Durbin-Watson statistic for some of the equations may provide the explanation of the  $V_m^2$  error. The negligible  $V^s$  (.5 percent) error implies that the majority of the essential explanatory variables have been included.

In  $C^D$  the error is higher, 5.4 percent and the main source is the central tendency bias (51 percent). The error due to variance ( $V^s$ ) is negligible but the  $r^2$  of these two series is extremely low indicating

that  $P_1$  and  $A_1$  do not move in the same direction at times, although  $S_p - S_A = 0$ .

It can be summarized that while the inequality coefficient is within tolerable limits and the essential explanatory variables have been included the model is handicapped by the method of estimation.

## CHAPTER VI

Concluding remarks

The preceding chapters were devoted to a discussion of the available theory and practice that may be used in formulating a policy model. In this concluding chapter some non-economic remarks will be made, which are essential if the material previously presented is to be of some use in the formulation of economic policy.

The central theme of the present chapter is the examination of the conditions that ought to exist in a country, so that, a consistent and operational model can be successfully implemented.

Most developing nations understand and accept the desirability of undertaking measures to initiate economic development. What most of them are lacking is the capacity to implement those measures. Although there are many reasons for this limitation, two broad types may be recognized.

- a) Limitations due to the political and administrative structure.
- b) Limitations due to social conditions.

Political leadership is a necessary condition for implementing economic development successfully. It is a rather common observation that in many developing nations political and economic interests may oppose development, since it (the development) will go against their established interests. To overcome these obstacles, a strong and effective political leadership and authority will have to impose a number of structural and institutional changes, so that, it will be ultimately possible to implement the objectives of the plan.

The presence of an effective political leadership will not be sufficient for the successful implementation of a development model, unless



it is accompanied by a reliable administrative machinery.

The functions that the public administration is responsible for, not only for formulating the model but also implementing it, are summarized in the following statement [13, p.562].

"For more effective implementation of a development plan, a specialized economic civil service is essential. It is also necessary for the planning agency to be able to influence the planning activities of individual government departments. There must also be a clear delineation of the responsibility for forming and carrying out economic policy, so that the relative bureaucratic strengths of the respective agencies are not allowed to determine the outcome of the plan. And since planning is a continuous process, there must be provision for the necessary revisions of the original plan and some guidance on when the several departments and agencies ought to deviate from the original established policies."

That all those conditions will exist in the administrative structure of a developing nation is something to doubt. The existence of a reliable administration requires a high level of educational facilities, something that is lacking in these countries.

Education is one of the many non-economic factors that should be taken into consideration in formulating a policy model. At times development models become almost useless and irrelevant if no consideration is given to a number of important non-economic components. Advanced policy models (from a technical point of view) tend most of the time to exclude

the incorporation of important non-economic elements.

Societies have shown different degrees of ability and desire in adapting to new forms of life. The policy model that establishes certain economic targets, the realization of which will result in changing the form of life in the community itself, will have very little success if some consideration for non-economic conditions has not been included.

A development plan to be successful requires not only an effective leadership, and competent administration but also popular support and cooperation. It is therefore essential that the plan should incorporate the conditions under which support and cooperation of the people will be forthcoming.

## LITERATURE CITED

1. Allen, R. G. D. Mathematical economics. London, England, McMillan and Co. Ltd. 1964.
2. Banco Central de la Republica Argentina. Memoria Anual de 1948. Buenos Aires, Argentina. 1949. Original not available; cited in Villanueva, Javier. Inflationary process in Argentina 1943-1960. p. 132. Buenos Aires, Argentina, Argentina Institute Torcuato Di Tella Centro de Tuvestigaciones Economias. 1964.
3. Bruno, M. Experiments with a multisectoral programming model. Unpublished multilited paper presented at the CAED Conference on the theory and design of economic development, Ames, Iowa, November 1965. Cambridge, Massachusetts Department of Economics, Harvard University. 1965.
4. Chakravarty, S. The logic of investment planning. Amsterdam, Holland, North Holland Publishing Co. 1959.
5. Chenery, H. B. and Bruno, M. Development alternatives in an open economy: the case of Israel. Economic Journal 72:79-103. 1962.
6. Duesenberry, J. S., Eckstein, D. and From, G. A simulation of United States economy in recession. Econometrica 28:749-809. 1960.
7. Durbin, J. and Watson, G. S. Testing for serial correlation in least square regression. Biometrika 38:159-178. 1951.
8. Goldberger, Arthur S. Econometric theory. New York, N.Y., John Wiley and Sons, Inc. 1964.
9. Hicks, J. R. Value and capital. 2nd ed. Oxford, England, Clarendon Press. 1964.
10. Hirschman, Albert O. The strategy of economic development. New Haven, Connecticut, Yale University Press. 1961.
11. Johnston, J. Econometric methods. New York, N.Y., McGraw Hill Book Company, Inc. cl963.
12. Mahalanobis, P. C. The approach of operations research to India. Sankhya: Indian Journal of Statistics 16:3-90. 1955.
13. Meier, Gerald M. Leading issues in development economics. New York, N.Y., Oxford University Press. 1964.
14. Meynard, G. Inflation and growth: some lessons to be drawn from Latin American experience. Oxford Economic Papers New Series 13:184-202. 1961.

15. Phillips, A. W. Stabilization policy in a closed economy. *Economic Journal* 64:290-323. 1954.
16. Pontryagin, L. S. Optimal regulation processes. *American Mathematical Society Translation Series* 2, 18:321-339. 1961.
17. Presidencia de la nacio Argentina. Consejo nacional de desarrollo. Plan nacional de desarrollo, 1965-1969. Buenos Aires, Argentina, author. 1965.
18. Ranis, G. and Fei, C. H. A theory of economic development. *American Economic Review* 51:533-565. 1961.
19. Simon, Herbert A. Causal ordering and identifiability. In Hood, William C. and Koopmans, Tjalling, C., eds. *Studies in econometric methods*. pp. 49-74. New York, N.Y., John Wiley and Sons, Inc. 1953.
20. Theil, H. *Economic forecasts and policy*. 2nd Rev. ed. Amsterdam, Holland, North-Holland Publishing Co. 1961.
21. Thorbecke, E. and Condos, A. Macroeconomic growth and development models of the Peruvian economy. Unpublished mimeographed paper presented at the CAED Conference on the theory and design of economic development, Ames, Iowa, November 1965. Ames, Iowa, Department of Economics, Iowa State University of Science and Technology. 1965.
22. Tinbergen, J. *On the theory of economic policy*. Amsterdam, Holland, North-Holland Publishing Co. 1955.
23. Tinbergen, J. *Economic policy: principles and design*. Amsterdam, Holland, North-Holland Publishing Co. 1956.
24. United Nations Economic Commission for Latin America. *Economic Survey for Latin America, 1951-1952*. 1954.
25. United Nations Economic Commission for Latin America. *Economic Survey for Latin America, 1954*. 1955.
26. United Nations Economic Commission for Latin America. *Economic Survey for Latin America, 1955*. 1956.
27. United Nations Economic Commission for Latin America. *Economic Survey for Latin America, 1957*. 1959.
28. United Nations Economic Commission for Latin America. *Statistical Bulletin for Latin America No. 1*. 1965.



29. Villanueva, Javier. Argentina's inflationary experiment (1943-1962). In Werner, Baer and Kerstenetsky eds., Inflation and growth in Latin America. pp. 355-360. Homewood, Illinois, Richard D. Irwin, Inc. 1964.
30. Villanueva, Javier. The inflationary process in Argentina 1943-1960. Buenos Aires, Argentina, Argentina Instituto Toccuato Di Tella Centro de Investigaciones Economicas. 1964.

## FOOTNOTES

<sup>1</sup>This section is based on Tinbergen, J. [22] and [23].

<sup>2</sup>The endogenous variables consist of the targets and irrelevant variables.

<sup>3</sup>If  $1 + m > N$  then we have  $[(1+m)-N]$  equational degrees of freedom.

<sup>4</sup> $x$  will have a unique solution if and only if the rank of matrix  $B$  is equal with the number of targets. The rank of a matrix is the number of linearly independent vectors which implies  $n=m$ .

<sup>5</sup>A diagonal matrix has non-zero values in the main diagonal and zeros in all other places.

<sup>6</sup>Square submatrix on the principal diagonal, the off diagonal elements being zero.

<sup>7</sup> $a'$  is the transpose of  $a$ .

<sup>8</sup>The meaning of 21 is that the end value of the  $n_{n+1}$  function is maximized.

<sup>9</sup> $s$  = marginal propensity to save

$I$  = investment

$G$  = government expenditures

$A$  = autonomous movement

<sup>10</sup> $p_2(T) = -1$  because the performance integral is minimized that is: it is desired to minimize the end value of the  $n+1$  target variables in 21.

<sup>11</sup>Since  $\lambda_1 + \lambda_2 + \lambda_3 + \lambda_4 = 1$  only three of the  $\lambda_i$ 's are independently determined

<sup>12</sup>Subscript (1) stands for the capital good sector and subscript  $c$  for consumption good sector.

<sup>13</sup>A rising industrial labor force implies an increase in urbanization.

At the same time money wages were substantially improved. These two factors were the reasons for the increase in the consumption of food-stuff.

<sup>14</sup>The capacity to import is referred here only with respect to the volume of export, and terms-of-trade.

<sup>15</sup>Reserves decline from 1700 million dollars in 1946 to a low 700 million at the end of 1949.

<sup>16</sup>Throughout this discussion there is a fundamental and crucial assumption that productivity does not increase.

<sup>17</sup>In the capacity to import the foreign reserves are not included, because for the period under discussion (i.e., 1945-1949) foreign reserves were used mainly for buying foreign owned companies.

<sup>18</sup>The 'worsening of terms-of-trade' for the industrial sector occurs as the result of a relative shortage of agricultural commodities seeking exchange for industrial goods in the market" [18, p.539]. By terms-of-trade Ranis and Fei imply here the price ratio of industrial commodities to agricultural commodities.

<sup>19</sup>The experience with Argentina has been that attempts to increase  $V_A$  by incentives, such as price support, have at most created speculative effects in sector A.

<sup>20</sup>This is not generally true. Brazil and many developing countries have had many serious inflations while at the same time output increased substantially.

<sup>21</sup>It is interesting to note, however, that in 1952 and 1953 imports declined substantially. This was due to the deflationary measures which

were undertaken at that time which depressed investment and, as a result, the need for capital goods and raw materials.

<sup>22</sup> $p^m$  = price of imports.

<sup>23</sup>The point must be made here that in the national statistics of Argentina, investment is partially determined by the level of import of capital goods, which implies that there is an inherited bias in the investment equation.

<sup>24</sup>The subtracted taxes are not net taxes, i.e., transfers were not added to  $(Y-T^d)$  to give net disposable income. This implies that the marginal propensity to consume has been overestimated in the consumption function.



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